JUNE, 1927

International Abstract of Surgery

Supplementary to

Surgery, Gynecology and Obstetrics

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CONTENTS

I. Index of Abstracts of Current Literature iii
II. Authors ix
III. Editor's Comment x
IV. Abstracts of Current Literature 463-548
V. Bibliography of Current Literature 549-570
VI. Volume Index ..... i-xxviii

Editorial communications should be sent to Franklin H. Martin, Editor, 54 East Erie St., Chicago
Editorial and Business Offices: 54 East Erie St., Chicago, Illinois, U. S. A.
Publishers for Great Britain: Bailliere, Tindall & Cox, 8 Henrietta St., Covent Garden, London, W. C.

CONTENTS—JUNE, 1927

ABSTRACTS OF CURRENT LITERATURE

SURGERY OF THE HEAD AND NECK

Head

MELCHIOR, E.: The Treatment of Furuncle of the Face 463

IVY, R. H.: Benign Bony Enlargement of the Condyloid Process of the Mandible 464

FITZWILLIAMS, D. C. L.: Ranula 464

Eye

VERREY, A.: Nagel's Anomaloscope 464

KHAN, W. A.: The Pathogenesis of Microphthalmia 464

DE SCHWEINITZ, G. E.: Essential Progressive Atrophy of the Iris: A Second Communication 464

ALLING, A. N.: Exfoliation of the Lens Capsule 465

MOORE, R. F.: The Significance of Retinal Hæmorrhages 465

BERENS, C.: Papilloedema in Relation to Ophthalmology 465

MAGITOT, A.: Intracranial Hypertension without Choked Disk 465

WHITE, L. E.: The Influence of Negative Pressure in the Sphenoid on the Optic Nerve 466

Ear

BERRY, G.: How the Deafened Are Helping the Otologist 466

EMERSON, F. P.: The Etiology and Treatment of Nerve Deafness 466

SPENCER, F. R.: Tuberculosis of the Middle Ear and Mastoid 467

JENKINS, G. J.: The Schwartze Operation for Acute Mastoiditis 467

FRASER, J. S.: The Results of the Radical and Modified Radical Operations 467

VON NEUMANN, H.: The Results of Operation for Mastoiditis 467

Nose and Sinuses

JOHNSTON, W. H.: Cerebrospinal Rhinorrhœa 467

Mouth

BÉRARD: Cancer of the Tongue and Radium Therapy 467

BÉRARD: The Late Results in Cancer of the Tongue Treated with Radium 468

FITZWILLIAMS, D. C. L.: The Surgical Aspect of Carcinoma of the Tongue 468

MILLIGAN, SIR W.: The Treatment of Carcinoma of the Tongue by Radiodiathermy 468

Pharynx

GUTHRIE, D: Acute Retropharyngeal Abscess in Childhood 469

Neck

HAMMETT, F. S.: Studies of the Thyroid Apparatus. XXXVII. The Rôle of the Thyroid Apparatus in the Growth of the Thymus 469

WILDER, R. M.: Hyperthyroidism, Myxœdema, and Diabetes 469

WAHLBERG, J.: Thyrotoxicosis and Its Reaction to Small Doses of Iodine 470

MOLL, H., and SCOTT, R. A. M.: Gastric Secretion in Graves' Disease 470

SCHUGT, H. P.: Tuberculosis of the Larynx: Treatment by Surgical Intervention in the Superior and Inferior Laryngeal (Recurrent) Nerve: A Report Based on Seventy-Nine Cases 470

SCHWYZER, A.: Operative Relief of Laryngostenosis 470

GRIVOT, LEROUX, and CAUSSE: Concurrent Development of an Epithelioma of a Vocal Cord and a Lymphosarcoma of the Base of the Tongue 471

VOORHOEVE, N.: The Stomach as a Vicarious Air Container After Extirpation of the Larynx 471

SURGERY OF THE NERVOUS SYSTEM

Brain and Its Coverings; Cranial Nerves

BULLOCK, W. O.: Traumatic Pneumocephalus, an Analysis and Report of a Case 472

DOTT, N. M.: Discussion on Pituitary Disorders. The Anatomical and Surgical Standpoint: Diagnosis; Treatment 472

HOLMES, G.: Discussion on Pituitary Disorders: Disturbances of Growth, of Sexual Functions, and of Metabolism 474

BÉRARD and DUNET: Meningoblastoma Treated by Deep Roentgen Therapy 477

TAVERNIER, L.: Paradoxical Results Immediately After Operations for Facial Paralysis 477

Peripheral Nerves

IACOBOVICI and BAUMGARTNER: The Technique of Phrenicotomy and Resection of the First Rib in the Surgical Treatment of Pulmonary Tuberculosis 478

DELAGÉNIÈRE, H.: Reparative Surgery of the Peripheral Nerves 478

Sympathetic Nerves

GABRIELLE and ROUQUIER: Periarterial Sympathectomy of the Brachial Artery for Severe Raynaud's Disease with Cyanotic Œdema of the Hand and Phlyctenules of the Fingers; Recovery 479

Miscellaneous

GULEKE: The Clinical Aspects of Neurinoma..... 479

SURGERY OF THE CHEST

Chest Wall and Breast

BRAINE, J. F. C., and MASSIE, G.: Carcinoma Mammæ: The Results of Treatment..... 481

BORAK, J.: Postoperative Irradiation of Breast Cancer..... 481

Trachea, Lungs, and Pleura

IACOBOVICI and BAUMGARTNER: The Technique of Phrenicotomy and Resection of the First Rib in the Surgical Treatment of Pulmonary Tuberculosis..... 478

LEMON, W. S.: Bronchiectasis in Childhood..... 482

SMITH, D. T.: Experimental Aspiratory Abscess... 482

DUJARIER, C.: Hydatid Cyst of the Left Lung: Extirpation; Closure without Drainage; Recovery..... 482

SHERMAN, J.: Primary Carcinoma of the Lung.... 482

JACKSON, B. H.: The X-Ray Diagnosis of Empyema 483

JACKSON, C.: The Bronchoscope as an Aid in the Diagnosis and Treatment of Pulmonary Infections..... 483

BUTLER, E. F.: The Surgical Management of Empyema..... 483

Heart and Pericardium

PRIBRAM: The Operative Treatment of Mitral Stenosis..... 483

Œsophagus and Mediastinum

CLERF, L. H.: Foreign Bodies in the Œsophagus.... 484

MANGES, W. F.: Roentgen Diagnosis of Foreign Bodies in the Œsophagus..... 484

ROVSING, T.: The Technique of My Method of Ante-Thoracic Œsophagoplasty..... 485

LERCHE, W.: Infected Mediastinal Lymph Nodes as a Source of Mediastinitis..... 485

Miscellaneous

BURRELL, L. S. T., ROBERTS, J. E. H., HASTINGS, S., MELVILLE, S., and Others: The Diagnosis and Treatment of Intrathoracic New Growths.... 486

SURGERY OF THE ABDOMEN

Abdominal Wall and Peritoneum

FORLINI, E.: The Retroperitoneal Fossæ and Treitz' Hernia..... 487

CORNIOLEY, M.: Mesenteric Cysts..... 488

Gastro-Intestinal Tract

FABER, K., HOLST, J. E., and NORGAARD, A.: An Investigation of the Function of the Stomach by Fractional Removal of the Test Meal..... 488

ANDRESEN, A. F. R.: Fractional Gastric Analysis with Histamine..... 489

KEEFER, C. S., and BLOOMFIELD, A. L.: The Significance of Gastric Anacidity..... 489

BAGGIO, G.: Experimental Gastric Ulcer from Obstruction to the Emptying of the Stomach.... 490

LAHEY, F. H., and JORDAN, S. M.: When to Operate in Cases of Peptic Ulcer..... 490

FINNEY, J. M. T.: The Surgery of Gastric and Duodenal Ulcer..... 490

FLINT, E. R.: Gastroduodenostomy..... 491

TROELL, A.: Benign Tumors of the Stomach, Especially from the Point of View of Diagnosis.... 491

CLAIRMONT, P.: Extirpation of Carcinoma of the Cardia..... 491

DELORE, X., MALLET-GUY, P., and BURLET, J.: Late Results of Resection of the Stomach for Cancer..... 492

PALMA, R.: Intestinal Absorption in Ileus from Occlusion..... 493

GUEULLETTE, R.: Intestinal Invagination: Its Clinical Forms in the Adult. An Experimental and Roentgen Study..... 493

BROCQ, P., and GUEULLETTE, R.: Intussusception in the Adult; Clinical Types and Roentgenological Study..... 494

PERROTTI, G.: The Plastic Use of Free and Pedunculated Flaps of Omentum in Suture of the Intestine..... 494

RIEDER, H.: Roentgenological and Cinematographic Observations of Organic Stenosis of the Pars Superior of the Duodenum..... 494

CHRISTOPHE, L., and HARTMANN, H.: Duodenojejunostomy for Treitz' Hernia..... 495

BONNET: Occlusion by Meckel's Diverticulum..... 496

LAVESSON, H.: Studies of So-Called Ileocæcal Invagination..... 496

HURST, A. F.: The Diagnosis and Treatment of Colitis 496

NORDMANN: The Development of Surgery of the Colon in the Last Twenty-Five Years..... 497

LIVINGSTON, E. M.: The Skin Triangle of Appendicitis: A Discussion of Its Significance and Its Diagnostic Value as Observed in More than 400 Cases of Acute Appendicitis..... 501

COLP, R.: External Fæcal Fistulæ in Acute Appendicitis..... 502

RICHARD, A.: Operative Treatment of Carcinoma of the Transverse Colon Exclusive of the Flexures..... 502

MILLER, N. F.: Atresia Ani Vaginalis, Its Correction; with the Report of a Case..... 502

Liver, Gall Bladder, Pancreas, and Spleen

HALL, W. W.: Useful Hepatic Function Tests..... 503

FRIEDENWALD, J., and ARMSTRONG, W. W.: Bromsulphalein Test in the Clinical Study of Liver Functions..... 503

MATEER, J. G., and HENDERSON, W. S.: Chronic Biliary Tract Disease: The Diagnostic Criteria 504
DENTON, J.: The Mode of Origin of Gall-Bladder Lesions 504
BÉRARD and MALLET-GUY: The Syndrome of Lithiasis of the Gall Bladder Due to Chronic Inflammation of the Pancreas 504
COUNSELLER, V. S., and MCINDOE, A. H.: Dilatation of the Bile Ducts (Hydrohepatosis) 505
BRULÉ: Intermittent Icterus in Calcareous or Cancerous Obstructions of the Common Bile Duct 505
DIAZ, G. L., and DUVAL, P.: Adenoma of the Hepatic Duct with Chronic Obstructive Icterus; Removal of the Tumor and Repair of the Hepatic Duct by a Flap from the Cystic Duct: Cure 506
CHAMBERLAIN, D.: Acute Pancreatitis 506
QUENU, J.: The Diagnosis and Treatment of Traumatic Rupture of the Spleen 506
ROWNREE, L. G.: Some Contributions to Our Knowledge of Diseases of the Kidney and Liver. 517

Miscellaneous

AUMONT and GRÉGOIRE: Severe Contusion of the Abdomen with Disinsertion of the Mesentery: Immediate Resection of the Right Half of the Colon: Open Fracture of the Patella 507
BÉRARD and DUNET: Roentgenography of a Subphrenic Abscess 507
BÉRARD and DUNET: A Hæmatoma of the Iliac Fossa in a Hæmophiliac; Operation Followed by Severe Hæmorrhage; Intravenous Injection of Citrate; Recovery 507
BRADY, L.: Solid Tumors of the Urachus 508

GYNECOLOGY

Uterus

YOUNG, M., and STEWART, C.: Cancer of the Uterus 509
HEIMANN, F.: Pre-Operative X-Ray Irradiation of Carcinoma of the Uterus 509

Adnexal and Periuterine Conditions

TUFFIER, T.: An Attempt to Protect the Ovaries During the X-Ray Treatment of Uterine Fibroids 509
COTTE, G., and BERTRAND, P.: Three Cases of Implantation of the Tube into the Uterus 510
HARTMANN, J. P.: The Treatment of Non-Tuberculous Adnexal Affections 510
AHLSTRÖM, E.: The Treatment of Non-Tuberculous Adnexal Inflammations 510

External Genitalia

WESTMAN, A.: The Results of the Treatment of Cancer Vaginæ at Radiumhemmet, Stockholm. 512

Miscellaneous

WESTMAN, A.: A Contribution to the Question of the Transit of the Ovum from the Ovary to the Uterus in Rabbits 512
JUNG, P., and SCHIRMER, A.: The Combination of the Pneumoperitoneal Roentgen Picture of the Female Pelvic Viscera with Hysterosalpingography 513

OBSTETRICS

Pregnancy and Its Complications

DE NOBELE and LAMS: The Effect of the Roentgen Rays on the Evolution of Pregnancy and the Development of the Fetus 514
LAFFONT and MÉLÉ: The Transplacental Passage of Staphylococci in a Fatal Staphylococcus Infection Complicated by Meningitis 514
BENCKERT, H.: A Case of Gravidity in a Uterine Diverticulum 514
BRINKLEY, A. S.: The Management of Acute Abdominal Complications During Pregnancy 515

Labor and Its Complications

TRILLAT, P.: A Special Position of the Head of the Fetus in Breech Presentation 515
ZARATE, E.: Partial Symphysiotomy and the Symphysiotomy of Frank 515
LUNDQUIST, B.: A Contribution to the Knowledge of the Etiology of Colporrhexis 516

Puerperium and Its Complications

DESCARPENTRIES: On the Results Obtained with Hæmolyzed Autogenous Blood in the Different Types of Puerperal Fever 516

Newborn

FLORIS: Birth Trauma and the Fate of Infants Extracted with Forceps 516

GENITO-URINARY SURGERY

Adrenal, Kidney, and Ureter

ROWNTREE, L. G.: Some Contributions to Our Knowledge of Diseases of the Kidney and Liver 517
HUNT, V. C.: Hydronephrosis 518
KLASON, T.: Cystic Kidneys 518
ATONNA, C., and MORRISSEY, J. H.: Polycystic Kidney 518
MERCIER, O., and PÉRARD, J.: A Case of Profuse Hæmaturia from Pyelonephritis Stopped by Ureteral Catheterization 519
MATRONOLA, G.: Statistics on Renal Tuberculosis. 519
SÖDERLUND, G.: A Contribution on the Roentgen Diagnosis of Renal Tuberculosis 519
MARION: Pyelography in the Diagnosis of Tumors of the Kidney 520
MARION: Mistakes That May Be Made in the Performance of Nephrectomy on the Basis of the Constant Alone 520

Bladder, Urethra, and Penis

CAMPBELL, M. F.: Bladder Dysfunction Secondary to Nerve Lesions 521

HUNT, V. C.: Bilocular Diverticulum of the Urinary Bladder 521
HAGER, B. H.: Clinical Data on Alkaline Incrusted Cystitis 521
CECIL, H. L.: Sarcoma of the Bladder: Report of a Case in Which a Total Cystectomy was Done .. 522
CASSUTO, A.: Explosion in the Bladder in the Course of an Electrocoagulation 523
FEDOROFF, S. P.: Total Excision of the Bladder for Malignant Tumor 524
DUBOUCHER and MICHON: A Case of Traumatic Rupture of the Perineal Urethra Treated by Immediate Urethrorrhaphy 524
VERRIOTIS, T., and DEFRISE, A.: Inflammatory Neoplasms of the Posterior Urethra in Chronic Gonorrhœa 524
GAUTIER, E. L., and CHEVASSU, M.: Four Different Forms of Urethral Polyps and Papillomata 525
KRETSCHMER, H. L., and FISTER, G. M.: Plastic Induration of the Penis: A Report of Sixteen Cases 525

Genital Organs

LAZARUS, J. A.: Deep Roentgen Therapy in Disease of the Prostate Gland 525
PUGH, W. S.: Surgical Aspects of Chronic Prostatitis. 525
GOLDSTEIN, A. E.: Bilateral Ligation of the Vas Deferens in Prostatectomy 525
MARION, G.: An Intervesicoprostatic Diaphragm After Prostatectomy 525
THOMAS, B. A., and BIRDSALL, J. C.: Vasopuncture Versus Vasotomy Relative to Stricture Formation: An Experimental Study on Dogs 526

Miscellaneous

LOWSLEY, O. S., and BUTTERFIELD, P. M.: Urological Conditions Among Children 526
DUVERGEY, DAX, and RAMARONY: Vaccination in Gonorrhœa; Result in 202 Cases of Antigonococcus Vaccination 528
WINTZ, H.: Experiences with Deep Roentgen Therapy in Urology 542

SURGERY OF THE BONES, JOINTS, MUSCLES, TENDONS

Conditions of the Bones Joints, Muscles, Tendons, Etc.

ROBERTSON, D. E.: Acute Hæmatogenous Osteomyelitis 529
CHIASSERINI, A.: Chronic Abscess of Bone 530
STONE, C. A.: Ossifying Hæmatoma 530
GOFORTH, J. L.: Giant-Cell Tumor of Bone 531
JEPSON, P. N.: Ischæmic Contracture 531
ADIE, W. J., and BANKART, A. S. B.: Spastic Paralysis 532
KULENKAMPFF, D.: A Celluloid Protection for the Finger, and a Contribution on the Treatment of Lacerated Extensor Tendons of the Fingers ... 532
BALENSWEIG, I.: Unusual Vertebral Injuries: Report of Cases 532
MATHIEU, P.: The Treatment of the Sequelæ of Coxalgia 533
LASSERRE, C., and MOUCHET, A.: Pseudo-Cystic Giant-Cell Tumor of the Femur in a Child 32 Months of Age; Currettage Followed by Filling of the Cavity with an Osteoperiosteal Graft from the Mother; Consolidation; Late Result .. 534
BERNSTEIN, M. A., and ARENS, R. A.: Diagnostic Inflation of the Knee Joint: A Clinical Radiological Study 535

Surgery of the Bones, Joints, Muscles, Tendons, Etc.

LAVALLE, R., and OMBRÉDANNE, L.: The Treatment of All Forms of Tuberculous Osteo-Arthritis by Bone Grafts 535
JOHANSSON, S.: On the Treatment of the Ischæmic Contraction of Muscles 535
PIERI, G.: Plastic Reconstruction of the Thumb ... 536
DEGA: Plastic Operation on the Thumb by Wierzejewski's Method and Its Late Results ... 536

Fractures and Dislocations

LERICHE, R.: The Treatment of Compound Fractures 536
RIEGER: The Degree of Working Capacity After Fractures 536

Orthopedics in General

LOWMAN, C. L.: The Underwater Gymnasium as an Adjunct to Orthopedic Surgery 537

SURGERY OF BLOOD AND LYMPH SYSTEMS

Blood Vessels

WINSLOW, N.: Extracranial Aneurism of the Internal Carotid Artery: History and Analysis of the Cases Registered up to August 1, 1925 ... 538

Blood; Transfusion

NATHER, K.: Pernicious Anæmia and Blood Transfusion 538
CARLTON, C. H.: Blood Transfusion in Children's Practice 539

Lymph Vessels and Glands

REICHERT, F. L.: The Regeneration of the Lymphatics 539

SURGICAL TECHNIQUE

Operative Surgery and Technique; Postoperative Treatment

WILSON, W. R.: Detoxication in the Treatment of Burns 540
BLAIR, V. P.: Repair of Defects Caused by Surgery and Radium in Cancers of the Hand, Mouth, and Cheek 540

Anæsthesia

MENNELL, Z.: A Question on the Teaching of Ether Anæsthesia: with a Report of Four Deaths Under Ether 540

DUNCAN, J. W.: Personal Experience with Ethylene Gas in Surgical Anæsthesia 541

PHYSICOCHEMICAL METHODS IN SURGERY

Roentgenology

MILLIGAN, SIR W.: The Treatment of Carcinoma of the Tongue by Radiodiathermy 468

BÉRARD and DUNET: Meningoblastoma Treated by Deep Roentgen Therapy 477

BORAK, J.: Postoperative Irradiation of Breast Cancer 481

JACKSON, B. H.: The X-Ray Diagnosis of Empyema 483

GUEULLETTE, R.: Intestinal Invagination: Its Clinical Forms in the Adult. An Experimental and Roentgen Study 483

MANGES, W. F.: Roentgen Diagnosis of Foreign Bodies in the Œsophagus 484

BROCQ, P., and GUEULLETTE, R.: Intussusception in the Adult; Clinical Types and Roentgenological Study 494

RIEDER, H.: Roentgenological and cinematographic observations of organic stenosis of the pars superior of the duodenum 494

BÉRARD and DUNET: Roentgenography of a Subphrenic Abscess 507

TUFFIER, T.: An Attempt to Protect the Ovaries During the X-Ray Treatment of Uterine Fibroids 509

JUNG, P., and SCHIRMER, A.: The Combination of the Pneumoperitoneal Roentgen Picture of the Female Pelvic Viscera with Hysterosalpingography 513

DE NOBELE and LAMS: The Effect of the Roentgen Rays on the Evolution of Pregnancy and the Development of the Fetus 514

SÖDERLUND, G.: A Contribution on the Roentgen Diagnosis of Renal Tuberculosis 519

MARION: Pyelography in the Diagnosis of Tumors of the Kidney 520

LAZARUS, J. A.: Deep Roentgen Therapy in Disease of the Prostate Gland 525

BERNSTEIN, M. A., and ARENS, R. A.: Diagnostic Inflation of the Knee Joint: A Clinical Radiological Study 535

LYSHOLM, E.: A Roentgenoscopic Apparatus for Cross Section and Localization 542

SIEVERT, R. M.: A Circulating Physical Department for Standardizing the Roentgen Radiation Used in Therapy 542

WINTZ, H.: Experiences with Deep Roentgen Therapy in Urology 542

HALBERSTAEDTER, L., and SIMONS, A.: An Experimental Contribution on the Postoperative Irradiation of Malignant Tumors as Regards Wound Healing and the Prevention of Local Recurrence 543

COLWELL, H. A., and THOMSON, M. S.: On Some Effects of Primary and Secondary Roentgen Rays upon the Skin of the Frog Tadpole 543

Radium

BÉRARD: Cancer of the Tongue and Radium Therapy 467

BÉRARD: The Late Result in Cancer of the Tongue Treated with Radium 468

MILLIGAN, SIR W.: The Treatment of Carcinoma of the Tongue by Radiodiathermy 468

HEIMANN, F.: Pre-Operative X-Ray Irradiation of Carcinoma of the Uterus 509

WESTMAN, A.: The Results of the Treatment of Cancer Vaginæ at Radiumhemmet, Stockholm. 512

BLAIR, V. P.: Repair of Defects Caused by Surgery and Radium in Cancers of the Hand, Mouth, and Cheek 540

FAILLA, G.: The Development of Filtered Radon Implants 543

ALLEN, E. V., BOWING, H. H., and ROWNTREE, L. G.: The Use of Radium in Internal Medicine: Further Experiences 544

MISCELLANEOUS

Clinical Entities—General Physiological Conditions

RABINOWITCH, I. M.: Diabetic Gangrene 545

SCHREINER, B. F.: A Summary of the Methods and Results of the Treatment of Cancer, Based on a Study of 3,246 Cases Admitted Between May, 1914, and May, 1925 545

General Bacterial, Protozoan, and Parasitic Infections

ASHHURST, A. P. C.: The Prognosis of Tetanus 547

SERIGÓS, E.: Proximal Hydatid Intradermal Reaction: A New Method of Obtaining More Sensitive Reactions 547

Experimental Surgery

HADEN, R. L.: Lesions in Rabbits Following the Intravenous Injection of Bacteria from Chronic Periapical Dental Infection 547

BIBLIOGRAPHY

Surgery of the Head and Neck

Head 549
Eye 549
Ear 550
Nose and Sinuses 550
Mouth 551
Pharynx 551
Neck 551

Surgery of the Nervous System

Brain and Its Coverings; Cranial Nerves 552
Peripheral Nerves 553
Sympathetic Nerves 553
Miscellaneous 553

Surgery of the Chest

Chest Wall and Breast 553
Trachea, Lungs, and Pleura 553
Heart and Pericardium 554
Œsophagus and Mediastinum 554
Miscellaneous 554

Surgery of the Abdomen

Abdominal Wall and Peritoneum 555
Gastro-Intestinal Tract 555
Liver, Gall Bladder, Pancreas, and Spleen 557
Miscellaneous 558

Gynecology

Uterus 559
Adnexal and Periuterine Conditions 559
External Genitalia 559
Miscellaneous 560

Obstetrics

Pregnancy and Its Complications 560
Labor and Its Complications 561
Puerperium and Its Complications 561
Newborn 562
Miscellaneous 562

Genito-Urinary Surgery

Adrenal, Kidney, and Ureter 562
Bladder, Urethra, and Penis 563
Genital Organs 563
Miscellaneous 564

Surgery of the Bones, Joints, Muscles, Tendons

Conditions of the Bones, Joints, Muscles, Tendons, Etc. 564
Surgery of the Bones, Joints, Muscles, Tendons, Etc. 566
Fractures and Dislocations 565
Orthopedics in General 566

Surgery of the Blood and Lymph Systems

Blood Vessels 567
Blood; Transfusion 567
Lymph Vessels and Glands 567

Surgical Technique

Operative Surgery and Technique; Postoperative Treatment 567
Antiseptic Surgery; Treatment of Wounds and Infections 568
Anæsthesia 568

Physicochemical Methods in Surgery

Roentgenology 568
Radium 568
Miscellaneous 569

Miscellaneous

Clinical Entities—General Physiological Conditions. 569
General Bacterial, Protozoan, and Parasitic Infections 570
Ductless Glands 570
Surgical Pathology and Diagnosis 570
Experimental Surgery 570
Hospitals; Medical Education and History 570

AUTHORS

OF THE ORIGINAL ARTICLES ABSTRACTED IN THIS NUMBER

Adie, W. J., 532
Ahlström, E., 510
Allen, E. V., 544
Alling, A. N., 465
Andresen, A. F. R., 489
Arens, R. A., 535
Armstrong, W. W., 503
Ashhurst, A. P. C., 547
Atonna, C., 518
Aumont, 507
Baggio, G., 490
Balensweig, I., 532
Bankart, A. S. B., 532
Baumgartner, 478
Benckert, H., 514
Bérard, 467, 468, 477, 504, 507
Berens, C., 465
Bernstein, M. A., 535
Berry, G., 466
Bertrand, P., 510
Birdsall, J. C., 526
Blair, V. P., 540
Bloomfield, A. L., 489
Bonnet, 496
Borak, J., 481
Bowing, H. H., 544
Brady, L., 508
Braine, J. F. C., 481
Brinkley, A. S., 515
Brocq, P., 494
Brulé, 505
Bullock, W. O., 472
Burlet, J., 492
Burrell, L. S. T., 486
Butler, E. F., 483
Butterfield, P. M., 526
Campbell, M. F., 521
Carlton, C. H., 539
Cassuto, A., 523
Causse, 471
Cecil, H. L., 522
Chamberlain, D., 506
Chevassu, M., 525
Chiasserini, A., 530
Christophe, L., 495
Clairmont, P., 491
Clerf, L. H., 484
Colp, R., 502
Colwell, H. A., 543
Cornioley, M., 488
Cotte, G., 510
Counseller, V. S., 505
Dax, 528
Defrise, A., 524
Dega, 536
Delagénière, H., 478
Delore, X., 492
De Nobele, 514
Denton, J., 504
Descarpentries, 516
De Schweinitz, G. E., 464
Diaz, G. L., 506
Dott, N. M., 472
Duboucher, 524
Dujarier, C., 482
Duncan, J. W., 541
Dunet, 477, 507
Duval, P., 506
Duvergey, 528
Emerson, F. P., 466
Faber, K., 488
Failla, G., 543
Fedoroff, S. P., 524
Finney, J. M. T., 490
Fister, G. M., 525
Fitzwilliams, D. C. L., 464, 468
Flint, E. R., 491
Floris, 516
Forlini, E., 487
Fraser, J. S., 467
Friedenwald, J., 503
Gabrielle, 479
Gautier, E. L., 525
Goforth, J. L., 531
Goldstein, A. E., 525
Grégoire, 507
Grivot, 471
Gueullette, R., 493, 494
Guleke, 479
Guthrie, D., 469
Haden, R. L., 547
Hager, B. H., 521
Halberstaedter, L., 543
Hall, W. W., 503
Hammett, F. S., 469
Hartmann, H., 495
Hartmann, J. P., 510
Hastings, S., 486
Heimann, F., 509
Henderson, W. S., 504
Holmes, G., 474
Holst, J. E., 488
Hunt, V. C., 518, 521
Hurst, A. F., 496
Iacobovici, 478
Ivy, R. H., 464
Jackson, B. H., 483
Jackson, C., 483
Jenkins, G. J., 467
Jepson, P. N., 531
Johansson, S., 535
Johnston, W. H., 467
Jordan, S. M., 490
Jung, P., 513
Keefer, C. S., 489
Khan, W. A., 464
Klason, T., 518
Kretschmer, H. L., 525
Kulenkampff, D., 532
Laffont, 514
Lahey, F. H., 490
Lams, 514
Lasserre, C., 534
Lavalle, R., 535
Lavesson, H., 496
Lazarus, J. A., 525
Lemon, W. S., 482
Lerche, W., 485
Leriche, R., 536
Leroux, 471
Livingston, E. M., 501
Lowman, C. L., 537
Lowsley, O. S., 526
Lundquist, B., 516
Lysholm, E., 542
Magitot, A., 465
Mallet-Guy, 504
Mallet-Guy, P., 492
Manges, W. F., 484
Marion, 520
Marion, G., 525
Massie, G., 481
Mateer, J. G., 504
Mathieu, P., 533
Matronola, G., 519
McIndoe, A. H., 505
Melchior, E., 463
Mélé, 514
Melville, S., 486
Mennell, Z., 540
Mercier, O., 519
Michon, 524
Miller, N. F., 502
Milligan, Sir W., 468
Moll, H., 470
Moore, R. F., 465
Morrissey, J. H., 518
Mouchet, A., 534
Nather, K., 538
Nordmann, 497
Norgaard, A., 488
Ombrédanne, L., 535
Palma, R., 493
Pérard, J., 519
Perrotti, G., 494
Pieri, G., 536
Pribram, 483
Pugh, W. S., 525
Quenu, J., 506
Rabinowitch, I. M., 545
Ramarony, 528
Reichert, F. L., 539
Richard, A., 502
Rieder, H., 494
Rieger, 536
Roberts, J. E. H., 486
Robertson, D. E., 529
Rouquier, 479
Rovsing, T., 485
Rowntree, L. G., 517, 544
Schirmer, A., 513
Schreiner, B. F., 545
Schugt, H. P., 470
Schwyzer, A., 470
Scott, R. A. M., 470
Serigós, E., 547
Sherman, J., 482
Sievert, R. M., 542
Simons, A., 543
Smith, D. T., 482
Söderlund, G., 519
Spencer, F. R., 467
Stewart, C., 509
Stone, C. A., 530
Tavernier, L., 477
Thomas, B. A., 526
Thomson, M. S., 543
Trillat, P., 515
Troell, A., 491
Tuffier, T., 509
Verrey, A., 464
Verriotis, T., 524
Von Neumann, H., 467
Voorhoeve, N., 471
Wahlberg, J., 470
Westman, A., 512
White, L. E., 466
Wilder, R. M., 469
Wilson, W. R., 540
Winslow, N., 538
Wintz, H., 542
Young, M., 509
Zarate, E., 515

EDITOR'S COMMENT

HOLMES' comprehensive discussion of the functions of the pituitary gland and the experimental and clinical results of pathological conditions involving the gland (p. 474), and Dott's study of pituitary disorders, with particular reference to their surgical treatment (p. 472), form an admirable summary of present-day knowledge of the hypophysis. Both writers emphasize the increasing emphasis that is being placed upon the hypothalamus and other portions of the brain adjacent to the hypophysis as the essential areas concerned in the production of certain so-called pituitary symptoms.

Nordmann's review of the development of the surgery of the colon during the past twenty-five years (p. 497) and the discussion following it bring out a number of divergent views, particularly with reference to the most satisfactory method of entero-anastomosis, the treatment of colitis, and the development and treatment of megacolon. With regard to methods of anastomosis, Melzner cites experimental evidence and von Beck clinical evidence in favor of an end-to-end anastomosis as advocated by Nordmann. Kausch, Keysser and Finsterer, on the other hand, employ a lateral anastomosis, but emphasize the necessity of leaving as small a blind sac as possible. In the discussion emphasis is laid upon the advantage of multiple stage operations in serious cases, and the primary formation of a cæcostomy or colostomy if symptoms of ileus are present.

A number of other particularly interesting papers on various phases of abdominal surgery from French and Italian clinics are reviewed in the section of this month's issue devoted to abdominal surgery. Perrotti's experimental study of the fate of free and pedunculated flaps of omentum used to cover intestinal incisions (p. 494) shows the importance of preserving the blood supply of such flaps if scar tissue formation and subsequent adhesions are to be avoided. Delore, Mallet-Guy and Burlet's report of the late results of resection of the stomach for cancer (p. 492) add some definite statistics to the literature of gastric carcinoma upon which the surgeon may base a conception of the prognosis of surgical treatment.

Cornioley's discussion of mesenteric cysts with a report of two cases (p. 488), and Bérard and Mallet-Guy's account of a patient presenting symptoms of biliary lithiasis as a result of stenosis of the pancreatic portion of the common duct (p. 504), suggest the necessity of keeping in mind these unusual conditions in establishing a differential diagnosis in the presence of abdominal pathology.

Rowntree's discussion on recent contributions to our knowledge of diseases of the kidney and liver (p. 517), and Wilder's study of diabetes associated with hyperthyroidism and with myxœdema (p. 469) emphasize the advances that are being made in the study of normal and disordered function in these particular fields and their repercussion on the entire field of medical and surgical therapy.

Hartmann's (p. 510) and Ahlström's (p. 510) discussion of the treatment of non-tuberculous adnexal affections, Bèrard's report of two cases of cancer of the tongue successfully treated by surgery and radium (pp. 467, 468), Robertson's experimental study of acute hæmatogenous osteomyelitis (p. 529), Hager's review of the clinical picture and the results of treatment in fifty cases of alkaline incrusted cystitis (p. 521), and Jepson's description of the experimental production of ischæmic contracture (p. 531) are a few of many other abstracts in this month's issue deserving of special attention.

INTERNATIONAL ABSTRACT OF SURGERY

JUNE, 1927

ABSTRACTS OF CURRENT LITERATURE

SURGERY OF THE HEAD AND NECK

HEAD

Melchior, E.: The Treatment of Furuncle of the Face (Zur Therapie der Gesichtsfurunkel). *Beitr. z. klin. Chir.*, 1926, cxxxv, 681.

With regard to the treatment of furuncle of the face there is considerable difference of opinion. Extreme partisans of strictly conservative treatment are opposed by the partisans of operation in every case. The author reviews the literature on the subject.

Besides the cervical congestion of Bier and suction hyperæmia, other conservative measures have been recently advocated, viz., the injection of autogenous blood encircling the infected area as done by Laewen, the serum therapy of Riedel, injections of carbolic acid, the vaccine treatment of Cruca, and the roentgen irradiation method proposed by Heidenhain.

The over-valuation of conservative measures is explained by the fact that the clinical character of facial furuncle is extremely varied and that the so-called benign forms are more common than the malignant forms. There is a preponderance of cases which Trendelenburg describes as "entirely innocent."

The presence of a very pronounced collateral œdematous swelling is not a sure criterion of malignancy. Œdema of the eyelid and chemosis do not necessarily indicate thrombosis of the cavernous sinus. A line of redness and swelling leading to the angle of the eye is not always a sign of thrombophlebitis of the angular vein. "Only severe involvement of the general health, especially high fever which, even in the beginning, is never absent and is frequently associated with chills, offers an indication of malignancy of the process."

Because of the difficulty in differentiating between malignant and benign furuncle of the face from the behavior of the local process, conclusions based on statistics as to the value of the different therapeutic methods are often erroneous.

Anatomically the malignant form of facial furuncle is a progressive phlegmon made up of very small isolated abscesses—a carbuncle. This tendency toward a carbuncle character is due to the rigid fixation of the skin of the face to the mimetic musculature (Rosenbach), by reason of which infectious material is easily pressed into the tissue spaces and the blood stream. The rich vascularization of the region favors the development of infectious thrombophlebitis. A fatal outcome is favored also by mechanical irritation produced by the patient, such as squeezing or pricking of the area and the scratching off of scabs.

Incision is done: (1) to abort the process at the outset, (2) to evacuate the collection of pus, or (3) to prevent the spread of a carbuncle. Incision made to abort the process in its early stages is futile as it relieves the tension only in its immediate vicinity and does not prevent the further progress of the condition. In a case of carbuncle with fluid pus, the question as to whether incision should be done or the spontaneous rupture of the abscess awaited is not of much practical importance. An objection made by partisans of conservative treatment to incision in cases of progressive phlegmonous carbuncle is that the opening up of the vessels and tissue spaces may have an unfavorable effect upon the course of the disease. This objection is not valid.

The outflowing blood carries out with it the infectious material, and it is hardly probable that under such circumstances infectious material could be sucked into the blood vessels.

The failure of the incision of a malignant furuncle of the lip to stop the process is due to the fact that an extensive general bacterial invasion has already occurred and the rendering of the primary lesion innocuous no longer will have any influence upon the course of the disease. In such cases the patient dies, not because of the operative procedure, but in spite of it. Any conservative treatment would fail also. Incision has an unfavorable effect only when

it is not done thoroughly enough. The judgment and technique of the surgeon determine the result.

With the patient under narcosis, the author makes a cross incision and undermines the tissues parallel with the surface as far as healthy tissue. This gives a good cosmetic result as it renders the making of several parallel incisions unnecessary. A very sharp knife is used in order to prevent pressure on the surrounding tissues. The transverse incision at the inner angle of the eye is extended down to the bone, cutting through the angular vein.

After the operation, care is taken to prevent all external trauma, the patient is kept in bed, and immobilization of the mimetic musculature is obtained by prohibiting talking and chewing. In cases of furuncle of the lip showing a tendency to progress, a proper incision is the surest means of preventing the further propagation of the condition. Operation is always indicated when chills and the local findings suggest thrombophlebitis.

In the period from 1909 to 1925, seventy-three cases were treated at the Breslau Clinic. Thirty-seven were treated by operation and thirty-six conservatively. There were five deaths, a mortality of about 7 per cent. Although four of the deaths occurred in the cases which were treated surgically, it is erroneous to conclude from this that conservative measures are superior to operation as there were no very severe cases in the group treated conservatively and many of the cases treated by operation were cases in which conservative measures had failed. DUSCHL (Z).

Ivy, R. H.: Benign Bony Enlargement of the Condyloid Process of the Mandible. *Ann. Surg.*, 1927, lxxxv, 27.

Bony enlargements of the condyloid process of the mandible present a definite clinical syndrome, viz., slowly progressive vertical elongation of one side of the face produced by lengthening of the ascending ramus of the mandible, the chin being pushed over toward the opposite side, failure of the upper and lower teeth on the affected side to meet, and little or no interference with motion of the jaw. The disease has been classified as an osteoma, exostosis, hyperostosis, hypertrophy, an inflammatory process, and "overgrowth." Most of the recorded cases were successfully treated by excision of the enlarged condyle.

The author adds three cases to the seventeen found in the literature. MORRIS H. KAHN, M.D.

Fitzwilliams, D. C. L.: Ranula. *Brit. J. Surg.*, 1927, xiv, 472.

"Ranula" is a loose term which has no scientific meaning but has been applied to all cystic swellings of the floor of the mouth whatever their form or origin. Twenty-one cases from the literature are reviewed. The author concludes that a ranula may arise in the salivary glands, including Blandin's gland, and in the mucous glands, but nowhere else. He believes there is nothing to favor the view that Fleishmann's bursa exists, and nothing to connect a ranula with the persistence of a cervical sinus.

J. FRANK DOUGHTY, M.D.

EYE

Verrey, A.: Nagel's Anomaloscope. *Brit. M. J.*, 1926, ii, 1105.

Nagel's anomaloscope permits a more exact diagnosis of color defects than lanterns and isochromatic tables. Three slits let in rays of light in such a manner that they are divided into their component parts by three prisms. Use is made of the green rays of one and the red rays of another to obtain pure green, red, or a combination of both. The mixture is matched with yellow let in by the third prism. With the second anomaloscope, which is essentially a spectroscope, a blue match can be made. Blue perception is rarely diminished in congenital dyschromatopsy. Macular blue blindness is found not only in retinal disorders, but also in diseases of the optic nerve. VIRGIL WESCOTT, M.D.

Khan, W. A.: The Pathogenesis of Microphthalmia. *Brit. J. Ophth.*, 1926, x, 625.

Khan reports four cases of microphthalmia showing different stages in the arrest of normal development. Deutschmann and Hess attribute the condition to intra-uterine inflammation. The author believes that this may be the cause of colobomata of the iris and staphyloma, but states that no pathological evidence of inflammation in microphthalmia has been reported. According to another theory, the cause of microphthalmia is an arrest of normal development. Ochi produced the condition in twenty-six experimental animals by causing a mechanical disturbance and by injecting salt solution and distilled water and air near the blastoderm. Consanguinity may also be a factor.

In one of the reported cases fright was the cause. Cessation of the menses usually corresponds to about the third week of gestation, when the optic vesicles are being formed. It was at this time that the mother realized her condition and her nervous system was upset by the shock.

SAMUEL A. DURR, M.D.

De Schweinitz, G. E.: Essential Progressive Atrophy of the Iris: A Second Communication. *Arch. Ophth.*, 1927, lvi, 10.

De Schweinitz reports a case of progressive atrophy of the iris which he kept under observation for fourteen years, reviews the reports of similar cases found in the literature, and gives the theories which have been advanced regarding the etiology of the condition.

In their typical manifestations these atrophies are unilateral and slowly progressive and are ultimately associated with the development of glaucoma. Aberrations of the iris characterized by such conditions as polycoria, bridge coloboma, persistent pupillary membrane, etc., must not be mistaken for

an essential atrophy of the iris which is not congenital and which is progressive.

The author includes in his report several illustrations of the iris and the field. In none of the cases was a posterior synechia demonstrable or were there any signs of present or past iritis except those observed by Hess and Harms.

From a study of the characteristic cases the author concludes that the atrophic process originates the glaucoma and not the reverse. He believes it has not been satisfactorily proved that any local or general conditions are causative factors.

L. L. McCoy, M.D.

Alling, A. N.: Exfoliation of the Lens Capsule. *Arch. Ophth.*, 1927, lvi, 1.

Alling reports seven cases having a direct bearing on the subject of exfoliation of the lens capsule. There is a slightly opaque disk on the center of the anterior surface of the lens with a white ragged border, the disk being slightly smaller than the pupil. Surrounding the opaque disk is a clear black zone where the capsule seems to be transparent. Beyond this clear zone are patches composed of white dots. On the pupillary edge of the iris is a row of white tags loosely attached to the pigmented border. Some of these tags were found loose in the anterior chamber. As they may float into the iris angle they may cause obstruction to the outflow and account for certain cases of glaucoma. Cataract in various stages was found in every case. Alling draws the following conclusions:

1. The membrane is not an exudate but an exfoliation of the anterior lamella.
2. The condition is a senile change, but has been observed in glass blowers exposed to infra-red rays.
3. Glaucoma is not present as a rule, contrary to Vogt's observation, but there is usually a cataract.
4. The formation of the central disk and its ragged border and the deposits at the pupillary edge are due to the denudation of the capsule outside the central disk by the iris movements.
5. Sometimes the exfoliated lamella comes off in sheets instead of flakes. Virgil Wescott, M.D.

Moore, R. F.: The Significance of Retinal Hæmorrhages. *Brit. M. J.*, 1926, ii, 1097.

No classification of retinitis has been found entirely satisfactory. Any vascular change in the retina noted with the ophthalmoscope calls for careful consideration. There are purely local diseases of the eye characterized by retinal hæmorrhage not dependent upon constitutional disease, but a retinal hæmorrhage calls for a most thorough study of the general condition.

This discussion is divided into four main sections, each with numerous subdivisions. Under general considerations is given a classification of retinal hæmorrhages excluding those due to disease of eye.

Section 2 deals with the different types of hæmorrhage. An attempt is made to associate each type with a constitutional disease.

The third section deals with the pathogenesis of hæmorrhages arising from the arterioles, capillaries, venules, and larger vessels. It is the author's opinion that the hæmorrhages in arteriosclerosis occur as the result of diminished nutrition of the endothelium with consequent leakage.

In the last section of the article the relation of the changes that take place to permanent sight defects is discussed. Moore believes that hæmorrhages produce no permanent change unless the external limiting membrane is ruptured. Of the 15 per cent of infants found to have retinal hæmorrhages at birth, relatively few have visual defects later.

Virgil Wescott, M.D.

Berens, C.: Papillœdema in Relation to Ophthalmology. *Laryngoscope*, 1926, xxxvi, 861.

In a series of proved cases of brain tumor, Parker found that a greater swelling of the disk occurred in the eye with the lower intra-ocular tension in about 80 per cent, regardless of the location of the tumor. This finding was made also in several of the author's cases. In the differential diagnosis of papillœdema, a study of the blind spot is important. If the observer's blind spot is normal, a rapid, accurate method is the following:

The observer and patient each hold one end of a string 100 cm. long below opposite eyes, the other eye being covered. The center of the string is marked and a test object passed in its plane, the blind spots of both being mapped out. Important information is obtained also with Biallart's pressure gauge. Roughly, the diastolic systemic blood pressure should be twice as high as the diastolic pressure of the retinal arteries. When a relative rise in the retinal diastolic pressure is noted, increased intracranial tension is present. When the X-ray shows the optic canals to be of normal or larger than normal size, neuritis is usually of extranasal origin.

The ophthalmologist should make repeated studies of the fields, blind spots, and central vision in all cases of papillœdema. Syphilis being ruled out, he should urge palliative decompression when vision is threatened, regardless of the etiology. Bereno gives a list of conditions producing choked disk.

Most important in the treatment is the preservation of vision. Resection of the optic nerve sheath as suggested by Muller may be considered. Decompressions are more often done too late than too early. When the optic canals are small, operation should be done earlier than in other cases. Cushing's statement that a swelling of over 4 diopters is caused by mechanical pressure should be borne in mind.

When there is no danger of loss of vision and the etiology is doubtful, it may be permissible to use mercury, arsenic, and iodides as well as tuberculin and vaccines. Samuel A. Durr, M.D.

Magitot, A.: Intracranial Hypertension Without Choked Disk. *Am. J. Ophth.*, 1926, 3 s. ix, 880.

Choked disk is a late symptom of intracranial hypertension. Increased intracranial pressure may

be diagnosed early by the Bailliart method. This consists in finding the blood pressure in the brachial and the retinal arteries.

During an ophthalmoscopic examination, pressure on the eyeball, gradually applied, produces a movement of the retinal arteries which ceases as the pressure is increased. This pressure is applied to the anæsthetized eye with a special dynamometer, and the pressure necessary to produce a movement of the arterial tree is noted. The pressure is then increased until all movement ceases. The first is the pressure added to the intra-ocular pressure, corresponding to the diastolic pressure of the retinal artery, and the second the systolic pressure. In normal persons, the retinal artery pressure is to the brachial artery pressure as 0.45 is to 1.0. Whenever this formula is inverted, there is a disturbance of intracranial or intra-ocular tension.

Four cases are reported in which there was no choked disk, but the intracranial tension was increased both by this method and by spinal puncture with a manometer. SAMUEL A. DURR, M.D.

White, L. E.: The Influence of Negative Pressure in the Sphenoid on the Optic Nerve. *Ann. Otol., Rhinol. & Laryngol.*, 1926, xxxv, 1163.

It is a matter of rather common observation that the opening of apparently normal sinuses is of benefit in optic neuritis. Patients with neuritis are usually suffering from obstruction to ventilation and drainage of the posterior sinuses caused by deviation of the septum or hypertrophy of the turbinate. Such obstruction causes negative pressure in the sinuses with the migration of the bacteria and toxins from the blood stream or lymphatics to the tissues adjacent the optic nerve and a consequent neuritis. It is the author's opinion that this accounts for the practically normal mucosa in most of these cases. The relief of negative pressure and depletion accompanying operation greatly benefit the neuritis.

From the work of Sluder, Lynch, and Brawley, the author concludes that negative pressure can be present without inflammation of the mucosa of the sinuses and is therefore a factor in the neuritis.

From comparisons of the optic nerve with the facial nerve in cases of Bell's palsy in which there was negative pressure within the middle ear, he concludes that a similar situation exists at times in the sphenoid and that negative pressure favors the migration of the bacteria and toxins to the optic nerve.

Thirty-three cases of optic nerve disturbance are reported. In 15 per cent the sphenoids and posterior ethmoids were opened. In one case, cicatricial obliteration of the sphenoid ostium with negative pressure was found.

About 50 per cent of the cases will recover spontaneously. Any definite focus should be removed. If none is found, surgical intervention is contra-indicated.

In 30 per cent of the cases the relief of nasal blocking is indicated in addition to removal of the focus.

In somewhat less than 20 per cent of the cases it is necessary to open the posterior sinuses to prevent optic atrophy. VIRGIL WESCOTT, M.D.

EAR

Berry, G.: How the Deafened Are Helping the Otologist. *Ann. Otol., Rhinol. & Laryngol.*, 1926, xxxv, 1082.

The otologist is helped by the work carried on throughout the country by the different constituent bodies of the American Federation for the Hard of Hearing, the purpose of which is the rehabilitation of the deaf. This organization prints news sheets for the deaf, conducts sales, studies and adjusts employment problems, encourages and teaches lip reading, and carries on a program for the prevention of deafness in school children. In the work with school children the co-operation of the local school board is sought. When this is obtained, the added cost to the board is more than repaid by the cutting down of repeaters in the schools.

MANFORD R. WALTZ, M.D.

Emerson, F. P.: The Etiology and Treatment of Nerve Deafness. *Ann. Otol., Rhinol. & Laryngol.*, 1926, xxxv, 1098.

All acute middle ear infections are characterized by tissue reactions in the conduction apparatus and by the action of the toxin on the end-organ, causing tinnitus, vertigo, and often increased sensitiveness to loud sounds, wind, etc.

The tinnitus or sensitiveness may precede the loss in tone perception.

Tone perception is first lost in that part of the scale which is represented by the whispered voice. The patient is quite deaf before the low limits are permanently raised; that is, after the subsidence of an acute tubotympanic catarrh he is quite deaf before the tube is again a factor.

In all chronic cases of middle ear deafness the loss of tone perception tends to become the same for both ears.

The loss in bone conduction is common to all chronic forms of middle ear disease and is only a step in the loss of tone perception.

The same type of hearing test with identically the same loss of tone perception in proportion to its chronicity is obtained in nerve deafness without involvement of the conduction apparatus.

In most cases of chronic deafness of any type improvement can be obtained if tone perception of the whispered voice is not below $\frac{6}{25}$ and if bone conduction is not decreased.

All types of deafness are prone to relapse with recurring infections.

In the treatment, all foci of infection in the body such as the tonsils, sinuses, lymphoid deposits, appendix, gall bladder, etc. should be cleared up by

operation and, if necessary, repeated treatment. The eustachian tube also should be cleared up, but is usually not the primary cause of deafness. Improved hygienic conditions and the use of the radio and similar tone excitations for notes not heard are beneficial. MANFORD R. WALTZ, M.D.

Spencer, F. R.: Tuberculosis of the Middle Ear and Mastoid. *Ann. Otol., Rhinol. & Laryngol.*, 1926, xxxv, 1073.

The author believes that tuberculosis of the middle ear is frequently not recognized because of the absence of pain which is typical and failure to find the tubercle bacilli in the pus when a mixed infection is present.

The infection is carried by the lymph or blood stream or is spread by continuity. The discharge is seropus and multiple perforations in the drum occur early. Frequently, granulation tissue is found around the margins of the perforations. The mastoid is involved late and is rarely tender. From time to time the X-ray shows slight clouding. Paralysis of the facial nerve occurs in about 50 per cent of the cases and by some otologists this is regarded as pathognomonic of tuberculosis of the middle ear and mastoid. The tubercle bacillus may or may not be found. The process is more extensive in children than in adults and may involve the entire temporal bone. The cervical glands, and especially the pre-auricular glands, are usually involved. The diagnosis is based on the insidious onset, the absence of pain before the rupture of the drum, the presence of multiple perforations and pale granulations, and the finding of the tubercle bacillus.

The treatment depends upon the patient's condition and should be general and local. For the latter, heliotherapy is of great advantage; the direct sunlight or quartz light may be used. In some cases a mastoid operation is necessary.

MANFORD R. WALTZ, M.D.

Jenkins, G. J.: The Schwartze Operation for Acute Mastoiditis. *Brit. M. J.*, 1926, ii, 1153.

Fraser, J. S.: The Results of the Radical and Modified Radical Operations. *Brit. M. J.*, 1926, ii, 1154.

Von Neumann, H.: The Results of Operation for Mastoiditis. *Brit. M. J.*, 1926, ii, 1157.

JENKINS emphasizes that in the treatment of mastoiditis the primary object should be the prevention of an extension of the septic process. In selected cases primary suture has been used to advantage, but the skin covering is thin and the depression marked. Drainage from the lower part of the mastoid wound has proved very satisfactory.

FRASER is of the opinion that failure to obtain a good result following the radical mastoid operation is due to failure to close the eustachian tube and get rid of the tubal air cells as well as to narrowness of the external meatus and a poor general condition. He reviews briefly the results obtained in cases he operated upon in the period from 1919 to 1925.

VON NEUMANN states that the cellular structure of the mastoid process is usually involved in acute otitis media but in the majority of cases of acute otitis media the mastoid inflammation resolves. In mastoid operations all diseased cells should be removed. JAMES C. BRASWELL, M.D.

NOSE AND SINUSES

Johnston, W. H.: Cerebrospinal Rhinorrhœa. *Ann. Otol., Rhinol. & Laryngol.*, 1926, xxxv, 1205.

The author reviews twenty cases of cerebrospinal rhinorrhœa which have been recorded in the literature and reports one case of his own. In this condition there is a communication between the brain and the nose. The opening may have been produced by an injury such as a fracture through the base of the skull, decay in the sinuses, or pressure necrosis from a tumor, or it may be a small congenital aperture in which a meningocele has developed and ruptured. In some cases the fluid may escape through a patent craniopharyngeal canal, through holes in the perforated plate which are deprived of nerve fibers, or along the perineural sheaths.

In most of the cases reviewed the spinal fluid pressure was increased as the result of a reduction of the cranial capacity, an increase in the brain volume, or over-production of fluid. The diagnosis is based on the escape from one nostril, usually the left, of a fluid which, on drying, does not stiffen linen, and which appears and disappears suddenly without any subjective symptoms in the nasal fossa. The fluid reduces copper. When 1 c.cm. of fluorescin is injected into the spinal canal, it is discharged through the nose. The condition must be differentiated from hydrorrhœa and a watery discharge from the antrum. MANFORD R. WALTZ, M.D.

MOUTH

Bérard: Cancer of the Tongue and Radium Therapy (Cancers de la langue et curiethérapie). *Lyon chir.*, 1926, xxiii, 630.

The author reports two cases of cancer of the tongue treated by surgery supplemented by radium irradiation. The first patient was a woman of 71 years who was admitted to the hospital with an indurated ulcer 10 cm. long on the right border of the tongue. There were no palpable glands. The ulcer was removed surgically on March 17, 1923. Histological examination showed it to be a prickle cell epithelioma with horny pearls. On March 24, four radium needles were implanted and left in place for six days, giving a dosage of 5.76 mc. On March 18, 1925, the patient returned with a small indurated mass on the right border of the tongue which interfered with mastication and speech. On its removal this mass showed the same histological structure as the former ulcer. At present the patient shows no trace of recurrence.

The second patient had had leucoplakia of the tongue for twenty-five years. This had been treated

irregularly with potassium iodide. Ulceration accompanied by difficulty in deglutition and pain irradiating to the ear began in July, 1924. On December 30, 1924, the patient entered the author's service with an enormous ulceration of the anterior and right part of the tongue resting on an indurated surface. Biopsy showed the lesion to be a malpighian epithelioma. Radical resection was performed into normal tissue, the anterior two-thirds of the tongue being removed. On February 2, 1925, a mask of felt containing 26 tubes with 6.8 mgm. of radium was applied. This mask covered the carotid, submaxillary, and subclavicular regions on both sides and was left in place seven days. The dosage was 218 mc.

At the present time the patient is in excellent condition. All of the carotid region is supple and there is no trace of gland recurrence. The appearance of the stump of the tongue is also satisfactory. The patient has learned to speak and is able to swallow without difficulty. She has gained 6 or 7 kgm. in weight. AUDREY G. MORGAN, M.D.

Bérard: The Late Result in Cancer of the Tongue Treated with Radium (Résultat éloigné d'un cancer de la langue traité par curiethérapie). *Lyon chir.*, 1926, xxiii, 620.

The author has treated three patients for cancer of the tongue by radium therapy. All are apparently cured after two or three years.

In one case there was an ulcer at the base of the tongue on the right side, involving the anterior pillar. Biopsy showed it to be a malpighian prickle-cell epithelioma. Palpation did not reveal any enlargement of the submaxillary or carotid glands. On February 7, 1924, nineteen tubes of radium were applied in a mask of wax covering the mastoid and the submaxillary and carotid regions on the right side. This mask was left on for seven days, giving a dose of 179 mc.

On May 9, 1924, eight radium needles were implanted in the periphery of the lingual tumor and left in place for eight days, giving a dose of 14.64 mc. The patient is now in excellent general condition. Locally there is no trace of the neoplasm; cicatrization is perfect; the base of the tongue and the anterior pillar are both normal. In the cervical region there are traces of a burn following radiodermatitis. Palpation does not show any gland enlargement. AUDREY G. MORGAN, M.D.

Fitzwilliams, D. C. L.: The Surgical Aspect of Carcinoma of the Tongue. *Brit. M. J.*, 1926, ii, 1089.

Milligan, Sir W.: The Treatment of Carcinoma of the Tongue by Radiodiathermy. *Brit. M. J.*, 1926, ii, 1902.

FITZWILLIAMS: Of the utmost importance in the surgery of the tongue is the preliminary treatment of oral sepsis and the teaching of the patient how to swallow. The intrabuccal operation is suitable for every case in which there is no extension to the floor of the mouth and no involvement of the lower jaw, the anterior pillar of the fauces, the tonsils, or the palate. Ligation of the lingual artery in the neck is unnecessary and will soon be abandoned. The tongue should be removed first, and then, after healing has occurred, a complete block dissection of the glands of the neck should be made.

The anæsthesia is induced preferably by warmed ether administered by laryngostomy and preceded by atropine. The tongue is held with silk ligatures, the pharynx is plugged with a marine sponge, and the incision is made through the mucosa, leaving a margin of about ¾ in. After separation and cutting of the geniohyoglossus, the styloglossus, and the hyoglossus muscles, the lingual artery is located, ligated, and divided. The growth is then removed and the wound toilet completed with care to leave no raw area. When this has been done, warm Friar's balsam is painted on the stump and the stitch in the back of the tongue is fastened to the cheek.

The after-treatment is directed toward rendering the patient as comfortable as possible. Morphine is withheld and the patient taught to irrigate the mouth with a warm potassium permanganate solution.

In the neck, the best results are obtained from a block dissection starting from under the chin and extending backward to the sternomastoid muscle, which is removed together with the internal jugular vein.

MILLIGAN'S article is summarized as follows:

1. Whenever possible, immediate surgical removal of the primary growth and of the lymphatic field draining the focus of infection should be done.

2. When surgical intervention is deemed impracticable, an attempt should be made to remove the growth with the diathermic knife or to destroy it by gradual coagulation with button- or spike-shaped electrodes.

3. When removal of the growth is contra-indicated, the insertion of unscreened radium tubes into its substance should be done.

4. Combined treatment by means of diathermic coagulation and radium implantation at times gives gratifying results.

5. In early cases the lymphatic field upon the affected side, and in advanced cases the lymphatic field upon both sides, should be removed by a surgical operation.

6. Irradiation of the lympathic field should be an invariable postoperative procedure and should be done preferably by the implantation of screened tubes or alternately by surface applications or X-ray therapy.

7. No preliminary irradiation should be employed if glandular deposits are to be removed by ordinary surgical procedures.

8. The diathermic cautery knife presents many advantages as compared with the scalpel for the removal of a cancerous tongue.

MANFORD R. WALTZ, M.D.

PHARYNX

Guthrie, D.: Acute Retropharyngeal Abscess in Childhood. *Brit. M. J.*, 1926, ii, 1174.

Guthrie reports a series of twenty cases of retropharyngeal abscess in childhood. Most of the patients were under 1 year of age.

The most characteristic symptom is difficulty in breathing. In the early stage there is a croupy cough. The temperature is seldom very high and may even be normal. Digital examination is the most certain diagnostic test, but should not be practised unless one is prepared to care for the abscess in case it should be opened.

The abscess should be opened preferably without the use of an anæsthetic as soon as the diagnosis is made. Following free drainage, convalescence is uneventful.

JAMES C. BRASWELL, M.D.

NECK

Hammett, F. S.: Studies of the Thyroid Apparatus. XXXVII. The Rôle of the Thyroid Apparatus in the Growth of the Thymus. *Endocrinology*, 1926, x, 370.

The normal course of thymus growth is still undetermined although there is a general belief that the gland undergoes a normal age involution independent of dietary and pathological influences.

By a series of experiments on the albino rat the author hopes to plot the normal curve of thymus growth. The conclusions drawn from these experiments to date are the following:

"A study of thymus growth in the albino rat under close and ideal conditions with respect to diet, environment, and health shows that there is no such phenomenon as the 'age involution of the thymus' up to the time of young adulthood, some time after puberty.

"The thymus does lose weight during puberty, and growth of the organ is resumed after the completion of the adjustment when the animals are under suitable conditions. Hence it is evident that puberty is not necessarily the initiator of a permanent progressive loss of weight or involution of the thymus. The pubertal loss of weight is simply a reaction to the general physiological disturbance of the period, and not to any specific relation of the thymus to gonadal incretory activity.

"The thymus is affected much more adversely by both thyroid and parathyroid deficiency than is the body as a whole.

"Thymic growth is retrogressive, i.e., weight is lost after thyroid or parathyroid removal at fifty days or thereafter.

"This is to be taken as an expression of an additive effect of the normal disturbing influence of the pubertal adjustment and the total disharmony induced by the glandular deficiencies. It is not an acceleration of involution.

"The distortion of thymus growth induced by thyroid and parathyroid deficiencies is best interpreted as a reaction to the general body disturbance. The evidence does not justify the assumption that the growth of the organ is specifically related to thyroid or parathyroid activity."

DON K. HUTCHENS, M.D.

Wilder, R. M.: Hyperthyroidism, Myxœdema, and Diabetes. *Arch. Int. Med.*, 1926, xxxviii, 736.

This is a study of thirty-eight cases of frank diabetes combined with states of hyperthyroidism and of one case of diabetes associated with myxœdema. Diabetes occurs in about 1.1 per cent of cases of hyperthyroidism. Exophthalmic goiter is less frequently complicated by diabetes (0.6 per cent of cases) than adenomatous goiter with hyperthyroidism (2 per cent). The study is not concerned with alimentary glycosuria, which is a much more common phenomenon in cases of hyperthyroidism and, in the author's opinion, does not represent any actual abnormality of carbohydrate metabolism as herein defined.

The symptoms of hyperthyroidism in a patient with diabetes may be obscured by those of diabetes. This is true particularly in cases with severe acidosis or diabetic coma. It it advisable, therefore, to consider the possibility of hyperthyroidism in all cases of diabetic acidosis.

A mild and possibly inconspicuous diabetes may be fanned into flame by hyperthyroidism, and severe hyperthyroidism (crisis) will readily provoke coma in a diabetic patient.

The requirement of insulin is increased by hyperthyroidism.

Iodine administered as compound solution in a dosage of from 20 to 60 minims daily to patients suffering from combined exophthalmic goiter and diabetes reduces the intensity of the diabetes. This effect parallels that upon the basal metabolic rate. Iodine has little or no influence on the course of diabetes associated with adenomatous goiter with hyperthyroidism, and is without effect in cases of uncomplicated diabetes.

Thyroidectomy is almost always followed by a considerable gain in tolerance in diabetes complicated by hyperthyroidism. Sometimes this is so great as to suggest a cure of the diabetes, but the response to glucose test meals may still reveal the persistence of the diabetic tendency. A cure may be simulated also when a hypothyroid state is induced by the operation. A case of juvenile diabetes is cited to illustrate the palliative effect of myxœdema developing in diabetes. When the basal metabolic rate of this child was restored to normal the previous diabetic state returned.

Special precautions are necessary in operations on patients with diabetes complicated by hyperthyroidism. The period of exacerbated toxicity which so often follows thyroidectomy is extremely dangerous. There is also considerable danger of provoking hypoglycæmia in these patients since they may be peculiarly sensitive to overdoses of insulin. Hypoglycæmic coma is differentiated from

other conditions of collapse by the fact that it is usually attended by a striking elevation of the blood pressure.

The phenomena exhibited by patients with diabetes combined with states of hyperthyroidism or hypothyroidism may be related to the general metabolic rate and thus may be explained without recourse to speculation as to a specific interdependence of the thyroid and pancreas. It appears that at lower metabolic rates the tissue cell is capable of utilizing a given amount of glucose with less insulin, and that with higher metabolic rates the requirement of insulin is disproportionately increased.

Wahlberg, J.: Thyrotoxicosis and Its Reaction to Small Doses of Iodine (Das Thyreotoxikosensyndrom und seine Reaktion bei kleinen Joddosen). *Acta med. Scand.*, 1926, Supp., xiv.

Under the term "thyrotoxicosis" the author includes all thyroid disturbances from the high-grade Basedow type to the borderline conditions resembling the simple neuroses.

Treatment with small doses of iodine was given in twenty cases of different character and severity, and the changes in the clinical picture, the basal metabolic rate, the pulse rate, and the weight were noted. The author summarizes the results as follows:

1. There is at first improvement, which occurs the more quickly and definitely the more pronounced the intoxication. This is manifested by a fall in the basal metabolic rate of as much as 59 per cent, a slowing of the pulse rate amounting to 40 beats a minute, recession of the exophthalmos, cessation of the diarrhœa, etc.

2. When the treatment is continued there occurs a change for the worse which is more prompt and marked in the severe cases. In the severe cases the condition may become worse than at the beginning of the treatment.

3. When the treatment is stopped, there occurs an exacerbation which is more marked in the more severe cases and may be worse than the condition at the onset.

Because of the last two facts, iodine therapy in thyrotoxicosis is purely a palliative measure. The author recommends its use before and after operation as is done by Plummer, but warns against its employment for curative purposes in severe thyrotoxicosis as in these it may cause great damage.

MICHAEL L. MASON, M.D.

Moll, H., and Scott, R. A. M.: Gastric Secretion in Graves' Disease. *Lancet*, 1927, ccxii, 68.

Of fifty cases of hyperthyroidism in which the Rehfuss test was made, twenty-two showed achlorhydria. In only 60 per cent was the achlorhydria accounted for by duodenal regurgitation. The authors attribute the achlorhydria to a two-fold mechanism: (1) overaction of the vagus which hastens the passage of the gastric contents through the stomach and causes duodenal regurgitation, and (2) a direct inhibitory action of the sympathetic on hydrochloric acid secretion.

J. FRANK DOUGHTY, M.D.

Schugt, H. P.: Tuberculosis of the Larynx: Treatment by Surgical Intervention in the Superior and Inferior Laryngeal (Recurrent) Nerve: A Report Based on Seventy-Nine Cases. *Arch. Otolaryngol.*, 1926, iv, 479.

The superior laryngeal nerve, essentially the nerve of the larynx, has played an important part in the treatment of tuberculosis of the larynx for a long time. The recurrent nerve has been considered in this connection only recently. An absolutely safe method of permanently overcoming pain on deglutition is resection of the superior laryngeal nerve. This is preferable to blocking of the nerve by alcohol injection, which is uncertain in its results. It cannot be stated, however, that resection of the nerve has a direct favorable effect upon the healing of the tuberculous process.

In the treatment of tuberculosis of the larynx, complete immobilization may be secured by paralyzing the motor nerve of the larynx—the recurrent laryngeal nerve. The method of choice is the injection of alcohol. The technique is simple and the resulting paralysis lasts for from four to eight weeks. Both recurrent nerves should not be paralyzed simultaneously.

Of fifteen cases of therapeutic paralysis of the recurrent laryngeal nerve, the laryngeal condition was improved after the treatment in nine, unimproved in three, and worse in two. In one case the treatment and duration of observation were insufficient for a conclusion. The therapeutic paralysis is especially beneficial in unilateral cases which have not advanced too far and the pulmonary condition is relatively favorable. SAMUEL KAHN, M.D.

Schwyzer, A.: Operative Relief of Laryngostenosis. *Ann. Surg.*, 1927, lxxxv, 40.

SCHWYZER reports a case of laryngostenosis in the treatment of which a special operative procedure was adopted.

The patient, a woman about 40 years of age, had been treated for one year for asthma. The laryngoscope showed great destruction of the epiglottis; the larynx looked like an ulcerating crater. It was impossible to see into the trachea, the larynx having a very narrow and tortuous lumen and presenting on all sides a bulky thickening with an irregular ulcerated surface partly covered by a dirty looking material. A Wassermann test proved to be 4 plus.

Under salvarsan treatment, a cicatricial stenosing change seemed to occur with the healing and was undoubtedly the cause of an increase in the severity of the dyspnœa. The appearance of the larynx, however, improved. On account of the dyspnœa, operation was necessary.

The thyroid cartilage was divided in a zig-zag manner and the two sides of the thyroid cartilage were pulled apart until the tips of the corresponding

projections rested upon each other. These were then fastened by a silk suture so that their tips met firmly.

If the larynx is not severely stenosed and does not require an intralaryngeal operation, as for instance in asphyxia from paralysis of the posterior cricoarytenoid muscles, the mucosa need not be opened. The stenosis may be relieved by a comparatively simple operation and the indefinitely prolonged wearing of a tracheotomy cannula avoided. The described method of widening the larynx was satisfactory. In reality this is a laryngoplasty.

MORRIS H. KAHN, M.D.

Grivot, Leroux, and Causse: Concurrent Development of an Epithelioma of a Vocal Cord and a Lymphosarcoma of the Base of the Tongue (Présentation d'un malade chez lequel évoluent simultanément un épithélioma epidermide d'une corde vocale et un lymphosarcome de la base de la langue). *Arch. internat. de laryngol.*, 1926, xxxii, 1118.

The patient whose case is reported, a man of 62 years, was examined in October, 1925, because of dysphonia of several months' duration. At that time a tumor which appeared to be a benign polyp was found on the left vocal cord. This was removed. Microscopic section showed it to be a malignant papilloma. In December, 1925, a piece of the vocal cord was removed and sectioned; examination revealed thickening of the epithelium in places with mitoses but no invasion in the depths of the cord. In January, 1926, the cord appeared practically normal except for slight reddening at the site of the previous growth, but at the base of the tongue there was an ulcer with moderate induration about it. Biopsy showed lymphoid sarcoma.

In February, 1926, the ulcer on the base of the tongue showed no change, but at the site of the papilloma on the left vocal cord there was a small red nodule. The patient had received anti-syphilis treatment since the last examination, in spite of a negative Wassermann reaction. Biopsy at this time showed the vocal cord to be normal, the nodule to be a malignant papilloma not invading the cord, and the lesion at the base of the tongue to be, as diagnosed before, a malignant lymphosarcoma.

Because of the clinically benign course of the condition and the patient's age and apparent resistance to these tumors, irradiation was regarded as preferable to operation.

MICHAEL L. MASON, M.D.

Voorhoeve, N.: The Stomach as a Vicarious Air Container After Extirpation of the Larynx (Der Magen als vikariierender Luftkessel nach Larynxexstirpation). *Acta radiol.*, 1926, vii, 587.

The author describes the X-ray findings in a case of œsophageal speech after extirpation of the larynx. In this case it was demonstrated that the stomach can perform the function of the lungs as an air chamber.

The stomach is filled with air, not by active swallowing, but by the aspiration caused by inspiratory movement. The air is expelled from the stomach by an expiratory movement in which the patient opens the cardia.

The manner in which the aspiratory and expulsory effect of the respiratory movement operates in the œsophagus and the stomach is explained.

The mechanism of spasmodic aerophagia by aspiration as described by Linossier necessitates the assumption that the oral part of the œsophagus and probably also the cardia are actively opened by the patient.

SURGERY OF THE NERVOUS SYSTEM

BRAIN AND ITS COVERINGS; CRANIAL NERVES

Bullock, W. O.: Traumatic Pneumocephalus, an Analysis and Report of a Case. *Surg., Gynec. & Obst.*, 1926, xliii, 750.

The author reports a case of pneumocephalus and briefly reviews fifteen cases collected from the literature. His patient was a 60-year-old man who was kicked in the head by a mule and was confined to bed for three weeks by severe headache. During the fourth week about a pint of clear fluid was discharged from his nose. Signs of increasing intracranial involvement then developed. Six weeks after the injury there were signs of involvement of the frontal lobes and at the base, and X-ray examination of the skull revealed a fracture of the right frontal region and a huge external pneumocephalus over the frontal lobes. As clear fluid escaped at intervals, there was doubtless a communication with the nasal cavity.

An exploratory craniotomy was done. The patient died ten days later from meningitis (?). Autopsy was not permitted.

Bullock believes that if an X-ray examination were made in all cases of head injury, pneumocephalus would be found more frequently. The mechanism is probably the forcing in of air by trauma or subsequent coughing or sneezing. In some cases the air has not appeared until weeks later. There are three types of the condition—diffuse external pneumocephalus, internal pneumocephalus (simple or combined), and true aerocele, a circumscribed accumulation of air in the brain substance. The course and outcome depend upon the disposition of the air and the reaction to infection in addition to the brain injury. Conservative treatment has given the best results, but if the escape of the air can be facilitated without much operative trauma, this may greatly help.

ALBERT S. CRAWFORD, M.D.

Dott, N. M.: Discussion on Pituitary Disorders. The Anatomical and Surgical Standpoint: Diagnosis: Treatment. *Brit. M. J.*, 1926, ii, 1040.

A study of 162 cases of hypopituitarism showed that all tumors and other destructive agents acting on the pituitary gland, with the single exception of the eosinophilic growth, cause hypopituitarism. The author discusses the physiology of the pituitary gland and the functions attributed to each portion.

THE POSTERIOR LOBE (PARTES NERVOSA, INTERMEDIA, AND TUBERALIS)

Our knowledge of the functions of the posterior lobe is still scant and uncertain. The action of the extract of the posterior lobe is well known, but the powerful pharmacological effect of the extract proves nothing as to the normal physiological function of the lobe. The single proved function of which Dott is aware is the regulation of the pigment cells in certain amphibia which remain pale after the removal of the pituitary body but become black again upon the injection of the extract and remain black after successful grafting of the pars intermedia tissue. In the dog, the total removal of the posterior lobe of the pituitary is attended by no apparent consequences. It appears quite unwarranted by known facts to attribute any definite symptom of pituitary disease to derangement of this structure.

THE ANTERIOR LOBE (PARS DISTALIS)

With regard to the function of the anterior lobe we have much more definite information. Dott gives an interesting historical sketch of the experimental work leading up to this knowledge. Nothing resembling acromegaly has been produced by the experimental administration of anterior lobe, a fact which raises the question as to whether the secretion of the eosinophilic tumor may be not only quantitatively but also qualitatively abnormal.

"PITUITARY" SYMPTOMS OF UNCERTAIN ORIGIN

"Pituitary" symptoms of uncertain origin include adiposity, an inconstant though striking feature which is more common and conspicuous in the young than the old. A comparison of this adiposity with that following castration and the genital hypoplasia of pituitary insufficiency suggests that it may be an indirect effect produced through the intermediation of the genital glands. The cause may be the involvement by a tumor of the fat-metabolism center in the hypothalamic region, the existence of which has been demonstrated by recent experimental work.

Diabetes insipidus is an inconstant accompaniment of pituitary disease. It has been attributed to lesions of the posterior lobe of the gland and to lesions of the hypothalamus. A study of tumors indicates that it occurs only when the growth is large enough to indent the base of the brain and does not always occur even then. Experimental evidence favors the cerebral theory, but it is difficult to ignore the fact that injections of extract of the posterior lobe will arrest the polyuria.

The diabetes mellitus of acromegaly is inconstant and may occur early or late in the condition. It may be extremely irregular and transient, thereby differing from typical diabetes mellitus. It reacts to insulin. In the case of a patient who died in diabetic coma the islets of Langerhans showed sclerosis, but it is difficult to associate an intermittent symptom with a sclerotic process.

Increased sugar tolerance has been observed in pituitary disorders, but may be found in any form of obesity with a lowered metabolism. Sugar ingestion tests are liable to lead to gross error.

PITUITARY DISORDERS IN RELATION TO DISTURBANCES OF ENDOCRINE FUNCTION

Dott describes the histology of the eosinophilic adenoma and the changes seen in acromegaly and gigantism. Of the many lesions which may exert a destructive effect on the gland and result in hypopituitarism, the chromophobe adenoma and the suprasellar cyst are the most common. The author describes these in some detail and reviews the findings in hypopituitarism. The mixed adenoma may cause signs of both hyperpituitarism and hypopituitarism in the same person. The histology of the tumor explains the definite syndromes. The tumor associated with the clinical signs of pathological hyperpituitarism is distinguished by eosinophilic cells, and it is reasonable to assume that these cells are responsible. As these cells closely resemble normal anterior lobe cells, their secretion may be assumed to resemble the normal anterior lobe hormone. No specific secretion would be expected from the chromophobe adenoma which represents the least specialized cell type and in which this cell usually attains only an embryonic phase.

LATENT HYPOPITUITARISM

Cases of latent hypopituitarism are a group with "pronounced neighborhood but inconspicuous glandular symptoms" (Cushing), which are recognized only from the effects of pressure upon the optic fibers. The condition occurs in persons over 40 years of age. This is easily explained by the fact that cutaneous changes and depression of sexual function are the only constant signs of hypopituitarism, and adiposity does not occur in later life. The changes therefore excite no notice in advancing age.

ADENOCARCINOMA OF THE PITUITARY GLAND

Adenocarcinoma of the pituitary gland is extremely rare. The few cases known to the author were those of patients over 45 years of age. The growth tends to invade the cranial bones and extend between them and the dura, causing progressive involvement of the cranial nerves. The dura seems to form a barrier against intracranial invasion, but the growth may produce metastases in the liver and elsewhere.

PITUITARY DISORDERS FROM THE ANATOMICAL AND SURGICAL STANDPOINT

From the anatomical and surgical standpoint, three main groups of pituitary disorders may be distinguished:

1. Tumors of intrasellar origin. By the time tumors of intrasellar origin cause symptoms, they have usually passed beyond the limits of the sella. These tumors are pituitary adenomata, the most common pituitary lesion. The author describes their growth and their effects on the sixth, fifth, and third nerves, the optic fibers, and the hypothalamus, and the results of obliteration of the third ventricle with hydrocephalus and pressure upon the inner surface of the temporal pole with olfactory hallucinations. Even a tumor of moderate size will surround the carotid arteries and insinuate itself between the layers of the basal dura. When this has occurred, the complete operative removal of the tumor is impossible.

2. Tumors of suprasellar origin. Tumors of suprasellar origin arise from or near the roof of the sella and enlarge primarily in the cisterna chiasmatis, although by the time they cause symptoms they have usually encroached on the sella and its contents by pressing the roof down from above. In their upward growth they usually pass behind the chiasm and toward the third ventricle and the interpeduncular space. They differ from the intrasellar tumors not only in their origin, but also in their relation to the subarachnoid space and the sequence in which they encounter the various structures upon which they press and the direction in which they exert pressure. Hypothalamic symptoms may occur early, and the field changes may differ as the pressure often comes from above and behind the chiasm. The X-ray picture of the sella differs; instead of the distention characteristic of pressure from within, such as occurs in cases of adenoma, there is a flattening by pressure from above with erosion of the posterior clinoid processes.

3. General pressure causing hypopituitarism. In long-standing cases of increased intracranial pressure the sella may be flattened and it is not surprising that signs of hypopituitarism are often present as in cases of hydrocephalus secondary to midbrain tumor or chronic adhesive meningitis. The author has seen pituitary signs so marked in such cases as to suggest primary pituitary disease.

The differential diagnosis between pituitary lesions of these three types is nearly always possible. It is of the utmost importance as the operative treatment differs radically and an incorrect approach may be not only inadequate but very dangerous. Adenomata are rare before the fifteenth year of age and uncommon before the twentieth year, whereas suprasellar cysts are frequently encountered in young children and the vast majority manifest themselves before the thirtieth year. Other aids in the diagnosis are the chronology of the symptoms, the character of the field defects, and the X-ray findings. The even ballooning of the intrasellar adenoma is characteristic and in marked contrast to the isolated erosion of the clinoid processes and the calcification of the suprasellar cyst. In the presence of general intracranial pressure there is not only erosion of the clinoids and the dorsum sella, but also pressure atrophy of other portions of the base or vault. It is not easy to distinguish between a suprasellar cyst or tumor without calcification and a cerebellar lesion with hydrocephalus, but ventriculography may help.

TREATMENT

The treatment of conditions related to the pituitary gland includes surgery, irradiation, and glandular therapy.

Surgery. The indications for surgery are fairly clear. Amelioration of glandular disturbances following operation has been reported in only a very few cases and as such disturbances are seldom of very serious inconvenience to the patient they do not constitute an indication for operation at the present time. On the other hand, the persistence of severe headache and progressive loss of vision demand operative measures. In cases with these symptoms it is important that surgery be undertaken reasonably early when the risk is least and benefit to vision is assured. Operation should be strongly urged for cases in which the visual field or acuity are steadily decreasing and for cases of any severity in which improvement is not occurring spontaneously. The surgical aspect of the adenoma is considered. The author prefers the transphenoidal approach and describes the technique. He approaches the suprasellar tumor from above. Subtemporal decompression plays a very unimportant rôle in pituitary surgery.

Irradiation. Deep irradiation has a powerful destructive effect on the neoplastic cells of adenomata but not on other tumors of this region so far as is known. Caution must be exercised in employing it as a primary treatment. In two cases cited it was followed by such reactive swelling in the tumors that the pressure symptoms became acutely aggravated and immediate sellar decompression was necessary. In early visual cases the irradiation may be tried without a preliminary operation, but when the optic fibers are seriously compressed it should not be employed until a transphenoidal operation has been done. As a postoperative adjunct, irradiation is very valuable and undoubtedly hastens improvement. Radium introduced by means of an endonasal applicator has been used by some, but the results are not known to be any better than those obtained with the X-ray, and a number of complications, such as necrosis of the adjacent bone, have been reported.

Medical treatment. Diabetes insipidus may be relieved by the administration of extract of the posterior lobe. This is given as an intranasal spray once or twice a day. Incidental pyrexia and lumbar puncture may occasionally cause temporary cessation of the polyuria and thirst.

The administration of anterior lobe and whole gland by various means has been extensively employed in clinical cases of hypopituitarism, but a review of the literature is by no means convincing as to its efficacy. However, a sure foundation is being laid in the experimental laboratory where definite amelioration of the symptoms of hypopituitarism has been obtained in mammals from intraperitoneal injections of large doses of anterior lobe substance. While the active principle has not yet been isolated and suitable means for its administration to human subjects have not yet been devised, there is no doubt that before long such means will be at our disposal.

GILBERT C. ANDERSON, M.D.

Holmes, G.: Discussion on Pituitary Disorders: Disturbances of Growth, of Sexual Functions, and of Metabolism. *Brit. M. J.*, 1926, ii, 1035.

The pituitary body is a complex structure composed of several distinct parts of different origin and function. All or one or more of the parts may be involved by disease. Recent investigations have raised doubt with regard to generally accepted hypotheses regarding the physiology of the pituitary body. The normal functions of the pituitary are so closely related to those of other glands, especially the sex glands, that a distinction of symptoms produced by disease of one of these glands is difficult.

It is generally believed that the pituitary body has an influence on growth, sexual development, bodily activity, and metabolism, these separate functions depending upon different parts. A hormone of the cells of the anterior lobe stimulates the growth of bones and influences the development of the skin and certain viscera. The pars intermedia and the posterior lobe control the development of the sex organs. The posterior lobe influences also the metabolism of carbohydrates. The pars tuberalis, which lies upon the infundibulum, is probably concerned with the secretion of urine.

The pituitary body may be disturbed by many types of disease. Primary tumor is probably the most common, but the gland may be involved also by metastatic growths. It may be injured by the pressure of growths in contiguous parts, the pressure of hydrocephalus, by syphilis, and by encephalitis. Extrapituitary conditions may block the secretion from the posterior lobe which enters the cerebrospinal circulation through the third ventricle or interrupt the nervous connections between the pituitary body and the hypothalamus. Defective development may result from congenital or mechanical causes or regressive changes.

Changes in the size and function of the pituitary gland may be associated with conditions of other endocrine organs, such as those occurring in pregnancy, following castration and atrophy of the sex glands, and in disease of the thyroid.

The clinical syndromes of pituitary conditions are usually divided into hypopituitarism and hyperpituitarism. This is probably the most useful classification at present, although it has not been proved that the secretions of the cells of an adenoma are identical with the normal. Many clinical symptoms are due to dyspituitarism or overactivity of some part of the gland and underactivity of some other part.

DISTURBANCES OF GROWTH

The most common disturbance of growth is acromegaly. This is generally associated with an adenoma of the anterior lobe of the pituitary. Although in a few cases no tumor or enlargement is to

be found, it is possible that in such cases there is a similar growth or over-function of an accessory pituitary. Benda has shown that the characteristic lesion in acromegaly is an adenoma which deviates so little from the normal structure that its secretion may be assumed to be similar. As a direct result of the increased secretion or possibly in combination with changes in other endocrine glands, the well-known bony changes occur, the skin becomes thick and inelastic, and the nose, lips, and tongue enlarge. Enlargements of the heart, liver, pancreas, and kidneys have been described, but are of no pathological significance. The colon has been found enlarged to two or three times the normal, this possibly accounting for the severe constipation with periodical enormous evacuations which occurred in those cases.

Gigantism. In pituitary disease in early life a general increase in height and bulk may be the most prominent feature. The growth may continue beyond adolescence. The normal proportions of the body may be maintained or the limbs may be abnormally long. The sex glands and the secondary sex characteristics may be underdeveloped. There are other factors predisposing to gigantism, but in some giants the pituitary is undoubtedly at fault, some overactivity of the anterior lobe providing the stimulus to skeletal growth possibly before fusion of the epiphyses. As an increase in the size of the anterior lobe is known to follow the removal of the testes or ovaries, it is possible that the large stature of eunuchs may be related to pituitary activity. Gigantism is not acromegaly in early life, but true acromegaly in children has been reported. The two conditions are closely related, however, as many giants develop symptoms of acromegaly in later life and acromegaly generally occurs in persons of large build. Similar regressive changes occur in the two conditions. In both, the patient is quite strong at first but later experiences a progressive weakness which may go on to cachexia. In both conditions the sexual functions are depressed and the patient shows apathy, indolence, a lack of energy and interest, and a narrowing of the emotional life. The giant is usually more infantile in his outlook.

Dwarfism and infantilism. Experimental evidence and clinical observation have indicated that lesions of the anterior lobe of the pituitary body in the young may cause an arrest of physical development. Such a lesion in childhood or early adolescence may result in dwarfism or an arrest of development with conservation of the normal adult proportions, or in infantilism in which growth is not necessarily stunted but the morphological characters of infancy and absence of sexual development persist beyond the age of puberty. True pituitary dwarfism is not common. Persons with this condition are merely miniature adults with fairly well developed sex glands and a normal hair growth. The author reports two cases having features suggesting suprapituitary growths. In one, a calcified tumor was shown by the roentgenogram and the patient became blind following bi-temporal hemianopsia. These cases generally show signs of premature senility in the third decade. Infantilism is more common. In this condition the stature may not be short, but the general development is slender and the configuration of the body is child-like, the sex organs are infantile, and the secondary sex characteristics are not developed. Obesity is a prominent feature.

ADIPOSITY

Experimental injury of the pituitary and especially of the posterior lobe may lead to an abnormal deposit of fat in the subcutaneous tissues and the viscera. A similar condition may accompany any pituitary lesion which injures the posterior lobe. It is seen in acromegaly, gigantism, dwarfism, and especially in the Froehlich syndrome. Extra-pituitary lesions causing dysfunction may cause the same picture. Cushing originally attributed it to a defect of the posterior lobe, but recent work suggests that it may not be the direct effect of the pituitary lesion but due to damage of adjoining centers in the base of the brain or the genital atrophy that usually accompanies pituitary disease. In a recent case of hypopituitarism seen by the author, a rapid and marked increase in weight was lost following the implantation of a testicular graft.

SKIN

The skin changes accompanying adiposity are characteristic, but occur also in cases without obesity in which atrophy or non-development of the genital organs is the chief feature. The skin is usually soft, thin, and smooth, often practically hairless, and as a rule dry, though rarely scaly. In young subjects its color is generally good, but in middle life it becomes thin and wrinkled, resembling the skin of old age. Rapid destruction of the entire pituitary body is associated with emaciation, somnolence, amenorrhœa in women, polyuria, atrophy of the sex glands, anæmia, slowness of the pulse and respiration, increasing muscular weakness, atrophy of the skin, and, in some cases, loss of hair and teeth.

DISTURBANCES OF SEXUAL FUNCTION

As a rule, sexual activity is depressed or lost in all forms of pituitary disease. This is frequently the first symptom. In certain cases of acromegaly, however, there may be an early stage of overactivity. The state of the sexual organs varies with the age at which the condition begins. If it begins before puberty, the sexual organs remain undeveloped, whereas if it begins after puberty the sexual organs may retain their normal size though frequently atrophy and regressive changes occur and there is loss of all manifestations of sexual function, including desire.

METABOLIC DISTURBANCES

Glycosuria is a variable symptom of pituitary disease and can be controlled by insulin. The carbohydrate tolerance is increased. The basal metabolic rate varies with the activity of the gland,

being low in hypopituitarism and high in hyperpituitarism. Polyuria and the clinical manifestations of diabetes insipidus have been attributed to disease of the posterior lobe of the gland, but recent investigations indicate that they are due to the hypothalamus even though their temporary relief by the injection of extract of the posterior lobe suggests that the posterior lobe plays a part. In cases of tumor, the blood pressure is generally decreased. Somnolence is a common sign of pituitary disease. The patient has a tendency to drop off to sleep in the day, but can be easily awakened. The somnolence is not to be confused with the stuporous condition associated with brain tumor or other disease causing an increase of the intracranial pressure. It is probably not a direct pituitary sign, as recent observations have demonstrated, in the region of the third ventricle, the existence of a center which controls or regulates sleep and this region may be pressed upon by tumors of the pituitary gland.

PRESSURE SYMPTOMS

In most pituitary diseases the primary lesion is a tumor capable of exerting compression on surrounding structures and thus producing other symptoms. Headache is variable. In some advanced cases it is absent, while in others it is one of the earliest and most prominent symptoms. When the tumor is within the sella, the headache is probably due to pressure upon the dural lining and is referred to the temples; in such cases it is a dull aching or severe bursting pain which is often continuous for hours or days. When the tumor is outside of the sella or extends from the sella, the headache is more severe but less constant, due to increased intracranial pressure, and generally referred to the forehead or behind the eyes; it may be very intense in the morning and accompanied by cerebral vomiting.

VISUAL SYMPTOMS

Visual symptoms are common but vary with the position of the tumor, the direction of its growth, and the various anatomical relations of the parts involved. Upward pressure generally first involves the optic fibers from each nasal half of the retina. In other cases the nerves are longer and the chiasm more posterior so that one or the other nerve is involved first; more rarely, the chiasm is placed anterior to the sella, when one of the optic tracts may be affected first. A pure bitemporal hemianopsia is rare as the decussating fibers seldom suffer alone and they are all affected only when the tumor has reached a considerable size. The earliest field defect is usually one upper temporal quadrant. This defect gradually extends toward the macula and invades the lower temporal quadrant. The opposite eye may be affected simultaneously or later.

In another common type, a scotoma, at first partial, but gradually becoming larger, is found on the temporal side of the fixation point. This gradually extends into the upper temporal quadrant and may invade the nasal side to some extent. In other cases there may be a gradual and general increasing contraction of the peripheral temporal field or merely a progressive diminution of vision throughout the whole temporal field. When the chiasm is more posterior, the pressure first affects one optic nerve, a diminution of the central vision often rapidly progresses to blindness of the eye, increasing pressure produces a temporal hemianopsia on the opposite side, or the nerve is compressed so that central vision suffers. If the chiasm is anterior, a homonymous hemianopsia to the opposite side may result but this is uncommon. In association with the loss of vision, the disks generally show a progressive pallor, but they may retain their normal color for a considerable time after the occurrence of the field defects. Papillœdema is rarely seen in cases of simple pituitary tumors.

OCULAR PALSIES

Diplopia, strabismus, and ptosis are not uncommon. One or all of the muscles supplied by the third nerve may be weak. The external rectus is commonly weak, but the fourth nerve generally remains unaffected. It has been stated that ocular palsies occur only when the tumor has extended intracranially or lies outside of the sella. While they are more common under such conditions, the author believes that they occur with intrasellar growths which may bulge lateralward and compress the nerves.

TRIGEMINAL PAIN

Trigeminal pain or numbness accompanied by sensory defects may occur, but probably does not when the tumor lies in the sella. Its presence is indicative of extrasellar extension or an extrasellar lesion.

ANOSMIA

Anosmia is rare, but may occur when an extrasellar neoplasm presses the olfactory tracts or the area olfactoria.

CEREBRAL SYMPTOMS

Cerebral symptoms are surprisingly rare in view of the amount of compression which may occur. There may be a mild hemiplegia. This is indicated only by an extensor plantar reflex due to compression of a cerebral peduncle and therefore is associated with extrasellar tumors. Damage to the mesial aspect of the temporal lobe may produce uncinate attacks.

THE PITUITARY AND THE HYPOTHALAMUS

It has been shown that in the hypothalamus there exist centers which, under experimental conditions at least, can affect the activity of the sympathetic system; also that this region is concerned with the regulation of temperature and metabolism, the secretion of urine, the control of sleep, and the function of the sex glands. Erdheim first suggested that disturbance of the hypothalamus is the cause

of many of the symptoms attributed to the pituitary gland, and this theory has been supported by clinical and experimental evidence. Several physiologists hold that the pituitary is not essential to life and that its complete removal may not be followed by characteristic symptoms. It seems definitely established that polyuria and temporary glycosuria may be produced by lesions of the tuber cinereum, and some claim that adiposity and regressive changes in the sex glands may result from injury to the base of the brain when the pituitary gland remains intact.

Numerous clinical cases reported within the last few years tend to substantiate these experimental findings. It may be that the "pituitary" symptoms resulting from lesions of the brain are the result of blocking of the pituitary secretions which normally reach the cerebrospinal fluid through the infundibulum. It seems, however, that certain clinical syndromes must be correlated with pituitary disease. Evidence of acromegaly may precede evidence of pressure upon the brain and is clearly associated with an overgrowth of the anterior lobe. It seems also that functional and anatomical sexual changes are of pituitary origin. Many of the less marked sexual disturbances may be the result of a disturbance of pituitary function.

TREATMENT

When the most prominent symptoms are of a hypopituitary nature the most rational treatment is the administration of the active substance of the gland. In some cases of adiposity the administration of thyroid has resulted in at least subjective improvement, and in cases of large adenomata it has repeatedly improved vision and reduced the headache. There is no convincing evidence that suprarenal, testicular, or ovarian preparations have any effect when they are administered by mouth. When the most urgent symptoms are due to pressure, surgery or irradiation is necessary. Unfortunately many cases reach the surgeon only when the tumor is quite large or has burst into the intracranial cavity. When this has occurred, only temporary relief of pressure can be expected. The author favors the frontotemporal approach.

Striking results have been reported also from X-ray treatment. Irradiation is claimed to be free from danger. This may be true so far as life is concerned, but the author knows of cases in which it has been followed by an increase of blindness and other pressure symptoms. Nevertheless, he believes that the method deserves a further trial, especially in the cases of patients who are poor surgical risks.

GILBERT C. ANDERSON, M.D.

Bérard and Dunet: Meningoblastoma Treated by Deep Roentgen Therapy (Méningoblastome traité par la radiothérapie profonde). *Lyon chir.*, 1926, xxiii, 621.

In February, 1924, the authors reported two cases of hemicraniosis, a hyperostosis of the bones of the skull secondary to a tumor of the meninges. In one of these cases the disease began in 1920 with tumefaction of the left frontoparietal region. The first physician consulted gave an intensive specific treatment which had no effect. There was a rapid decrease in vision, with the development of very marked exophthalmos and violent headaches. A diagnosis of osteosarcoma was made and the patient sent to the cancer station for roentgen treatment.

Roentgenography showed a tumor occupying the upper, external and postero-external walls of the left orbit. The left frontal and sphenoidal sinuses were intact. During October, 1923, the patient was given roentgen treatments, one in the left lateral region of the orbit, one below the orbit, and one above the orbit. A slight roentgen dermatitis developed but disappeared in six months. At the end of six months most of the symptoms had begun to decrease, the headache and dizziness had ceased, the temporoparietal swelling had decreased (it never disappeared entirely) and there was marked improvement in vision. The patient is now able to sew and read a little with the left eye, with which, for several years, she had not been able to do more than distinguish between light and darkness. The exophthalmos was not very much improved.

AUDREY G. MORGAN, M.D.

Tavernier, L.: Paradoxical Results Immediately After Operations for Facial Paralysis (A propos des résultats paradoxaux immédiats après les opérations pour paralysie faciale). *Bull. et mém. Soc. nat. de chir.*, 1926, lii, 992.

A soldier with complete facial paralysis from a mastoid bullet wound suffered from conjunctival irritation due to inability to close the eyelids. The wound was well healed. As the loss of facial nerve substance in the wound prevented local repair, Tavernier anastomosed the facial with the hypoglossal nerve.

The incision extended from in front of the sternocleidomastoid to the retro-auricular furrow and the great horn of the hyoid. The facial nerve was sectioned near the stylomastoid foramen. The hypoglossal was easily found without any freeing of the neurovascular cord at the point where it crosses the internal carotid. The hypoglossal was unsheathed and a bundle equal to about two-thirds of the nerve trunk was cut, reversed upward, and sutured to the peripheral end of the facial nerve by a very fine linen thread.

The patient noticed closure of the eyelid as soon as he awoke from the anæsthesia. The eyelid could not be shut voluntarily nor by attempts at contraction of the face, but when the eye looked downward the lid fell, giving the impression of a passive fall from simple relaxation of the levator palpebræ. The eyelid on the affected side closed gently but involuntarily after the eyelid of the other eye. Before the operation the lids were never closed even in sleep.

The operation did not modify the paralysis of the remainder of the facial nerve distribution. Closure

of the eyelid permitted healing of the conjunctivitis. The result has persisted for seven years since the operation. The hypoglossal-facial anastomosis immediately modified the state of the eyelid muscles although no regeneration of the facial nerve occurred.

Tavernier attributes the phenomenon, not to the suture of the hypoglossal and facial nerves nor to the section of the facial which was already severed several millimeters higher, but to some action on the sympathetic fibers in the operative field. The superior sympathetic cervical ganglion was not involved. The pericarotid plexus was touched only in an extremely superficial way because the hypoglossal was located and unsheathed easily without a search. There was a greater chance of an effect on the sympathetic fibers accompanying the stylomastoid artery because isolation of the facial nerve with the surrounding vessels was difficult.

Botreau-Roussel has reported immediate recovery of movements in facial paralysis after removal of the superior cervical sympathetic ganglion.

WALTER C. BURKET, M.D.

PERIPHERAL NERVES

Iacobovici and Baumgartner: The Technique of Phrenicotomy and Resection of the First Rib in the Surgical Treatment of Pulmonary Tuberculosis (La technique de la phrénicotomie et de la résection de la premiere côte dans le traitement chirurgical de la tuberculose pulmonaire). *Bull. et mém. Soc. nat. de chir.*, 1926, lii, 994.

In the procedure described, the supraclavicular region is well exposed and the thorax elevated with the scapula free, the shoulder depressed, the head in extension, and the face turned toward the opposite side. A U-shaped incision is made from the acromioclavicular articulation along the external half of the clavicle and along the posterior border of the sternomastoid to the level of the hyoid bone. After the superficial cervical fascia is broken through and the middle together with the omohyoid is divided, the brachial plexus and scaleni are exposed. This permits recognition of the phrenic nerve and the first rib.

The phrenic nerve, including its roots and anastomoses is dissected. Iacobovici believes that for complete hemidiaphragmatic paralysis all of the anastomoses, and especially the anastomosis to the subclavian nerve, must be destroyed, and he sections them at the time of exposure. Baumgartner, however, considers that dissection of the anastomoses is unnecessary and only prolongs the anæsthesia and operation unduly since evulsion of the nerve for a distance of 15 cm. must destroy them.

In resection of the first rib, Iacobovici protects the trunks of the brachial plexus by retracting them. The insertion of the underlying scalenus muscle is rongeured free. A portion about 4 cm. long (from the costotransverse ligament behind to the crossing with the clavicle in front) is laid bare. Complete isolation of the rib requires care, especially to avoid injuring the venous plexus posteriorly and the pleural dome within. The rib is cut as near as possible to the costotransverse articulation and lifted up, and a portion about 4 cm. long is resected. In resection of the rib further anteriorly there is danger of injury to the subclavian artery.

After rib resection and partial repair of the musculo-aponeurotic layers the two roots of the phrenic are divided and the nerve is avulsed according to the classical procedure. The operation is accomplished without bleeding. Iacobovici postpones nerve avulsion to the end of the operation in order that, at the moment of avulsion, when accidents may occur, the patient will not be profoundly anæsthetized.

Phrenicectomy is of value in tuberculosis of the base or apex of the lung to place the lung at rest and to facilitate the collapse of a cavity. If the cavity is kept gaping by peripheral adhesions, the ascension of the diaphragm permits some degree of collapse of the cavity walls, but the release of an apical adhesion and effacement of the lung apex by resection of the first rib greatly improves the therapeutic result.

Phrenicectomy as a preliminary to thoracoplasty (Sauerbruch) prepares for collapse of the diseased lung, decreases the severity of the accidents associated with extensive rib resection, and lessens the total strain thrown on the opposite lung. Total thoracoplasty requires resection of the first rib. As this is difficult by the posterior route, its accomplishment during preliminary phrenicectomy renders the secondary thoracoplasty easier and more efficacious.

Phrenicectomy combined with rib resection through one incision is of value in grave forms of pulmonary tuberculosis in which surgical intervention must be minimal.

In a case of tuberculosis in which thoracoplasty was contra-indicated by the evolution of the disease, Bérard performed a phrenicectomy and short parasternal resections of the three upper ribs through one incision.

WALTER C. BURKET, M.D.

Delagénière, H.: Reparative Surgery of the Peripheral Nerves (Chirurgie réparatrice des nerf périphériques). *Paris chir.*, 1926, xviii, 169.

Delagénière has done 144 nerve sutures with 124 completely successful results, sixteen partially successful results (almost all in mixed nerves), and four failures. In general, the sooner the suturing is done after the accident the more rapid the repair and the return of physiological function. However, it is never too late to restore a nerve; Delagénière has had completely successful results in cases operated upon twenty-eight months after the accident.

Generally the repair is slower after complete anatomical section than after physiological interruption from crushing. Motor nerves regenerate more quickly than mixed nerves.

The differentiation between anatomical section and physiological interruption is sometimes impossible. In such cases it is better to wait for three or four months to determine whether physiological function will not be restored. If the wound is recent it may be a question of revivification rather than of section, but if the wound is old there will be a nodule on each end of the nerve and quite extensive resection may sometimes be necessary.

As great economy as possible should be exercised in resection to avoid difficulty in suturing, but the resection must be carried into normal nerve tissue. Particularly in mixed nerves, care must be taken to unite each fasciculus of the central end to the corresponding one of the peripheral end. Sometimes a small vessel will be seen on the surface which will serve as a guide. The author uses very fine needles and fine silk for suture, taking care to pass the threads only through the sheath and not through nerve substance. The two ends should be brought only into contact without overriding. The sutures must be non-absorbable and strong enough to keep the ends in contact during the process of repair. This may be aided by immobilization of the limb.

If the resection is extensive enough so that the ends cannot be brought together easily, flexion of the limb may help, but if there is much of a gap it is better to resect a piece of bone or suture in two stages, leaving a long enough piece of cicatricial tissue to fill the gap and resecting it at a second operation after it has had time to serve as a guide to growing nerve fibers. If nerve grafting is necessary to fill the gap, autografts are to be preferred. It is possible to fill a gap of as much as 13 cm. in a mixed peripheral nerve with a double fragment of musculocutaneous nerve from the leg of the patient with perfect functional results.

The author sees no advantage in enveloping the nerve in tubes of aponeurosis or various other materials. This procedure is not only useless, but interferes with the success of the suture. The only useful precaution is the placing of the sutured nerve in healthy muscle tissue, preferably an interstice in the muscle. Drainage is not necessary unless a bone callus has been opened in the liberation of the nerve. The skin is sutured with horsehair, and if necessary the limb put in plaster to limit its movements to the desired degree. A nerve suture does not cause any pain after the operation. If the limb has been placed in flexion to safeguard the suture the flexion should be maintained for fifteen days or, preferably, a month. When the plaster has been removed the patient should be allowed to recover his movements gradually without massage or electricity. In a comparative study of series of cases the author found that electricity does not help in the regeneration of the nerve.

He finds that simple liberation of the nerve from scar tissue is rarely effective. In 113 nerve liberations he performed during the war the results were not nearly so good as those of resection and suture.

AUDREY G. MORGAN, M.D.

SYMPATHETIC NERVES

Gabrielle and Rouquier: Periarterial Sympathectomy of the Brachial Artery for Severe Raynaud's Disease with Cyanotic Œdema of the Hand and Phlyctenules of the Fingers; Recovery (Sympathectomie périartérielle humérale pour maladie de Raynaud à forme grave, avec œdème cyanotique de la main et phlyctènes des doigts; guérison). *Lyon chir.*, 1926, xxiii, 658.

The patient whose case is reported was a soldier 21 years of age who had had symptoms of Raynaud's disease for years. He stated that his hands, ears, and nose had always been extremely sensitive to cold. Recently the disturbance had rendered his left hand useless. Both the palm and back of the hand were swollen and hard so that no indentation could be made. The skin was violet colored. On the dorsal surface of the two last phalanges of the index and middle fingers there were little zones of necrosis of the epidermis.

The fingers as well as the hand were infiltrated. Active movements of the fingers were impossible, and movement of the wrist was impaired. There was no sensation in the hand. Sensation became normal 3 or 4 cm. above the radiocarpal joint. The left hand was cold, and there was a considerable difference in the temperature of the right and left hands. The radial pulse was normal on both sides. The patient was in an almost constant condition of neurovegetative disequilibrium; the slightest peripheral stimulation caused considerable variations in maximum and minimum pressure.

Sympathectomy of the left brachial artery was performed from the origin of the superior profunda to the elbow. The artery was denuded as completely as possible. The vessel became filiform and almost immediately the color of the back of the hand changed from violet to a rose color and the local temperature rose considerably. When the patient was put to bed his hand was warm, and after forty-eight hours the œdema had disappeared completely and movement and sensation were normal. Arterial tension was practically the same on both sides, though possibly a little decreased on the left side. The immediate result is excellent, but as the patient is still sensitive to changes in temperature, and particularly to cold, some reserve is necessary in the prognosis as to the end-result.

AUDREY G. MORGAN, M.D.

MISCELLANEOUS

Guleke: The Clinical Aspects of Neurinoma (Zur Klinik des Neurinoms). *50 Tag. d. deutsch. Ges. f. Chir.*, Berlin, 1926.

The term "neurinoma" is applied to a peculiar form of tumor having its origin in nerve tissue. Its pathogenesis and position among neoplasms are still matters of considerable controversy among pathologists.

The author reviews the clinical aspects of neurinoma on the basis of the sixty cases reported in the

literature to date and a series of cases that he himself has had the opportunity to study.

Neurinomata may be divided into three groups. Those of Group 1 have their origin in the brain. The author has had five cases in which the tumor occurred in the cortex and base of the cerebrum, one case in which it occurred on the parietal lobe, and four cases in which it involved the acusticus. The symptoms of the cerebral neurinomata were the same as those produced by other brain tumors.

Neurinomata of Group 2 occur within the spinal canal or close to the vertebral column. The author has observed two cases of intradural tumors. In these, the tumor was in close relationship to the posterior roots of the spinal cord, showing a predilection for these structures as compared with the anterior roots, and from this site grew laterally alongside the transverse processes so that in the roentgen picture it appeared as an hourglass-shaped tumor in the mediastinum. In two other cases the tumor was close to the cervical vertebræ, originating in the fourth cervical vertebra and growing laterally.

Neurinomata belonging to Group 3 occur in the peripheral nerves. In one of the cases reviewed a tumor the size of a walnut occurred in the sciatic nerve and in its growth separated the fibers of the nerve. In another case the tumor had its origin in the peroneus nerve.

The symptoms are as varied as the locations of the tumors. Two-thirds of all neurinomata are found at the points of exit of the nerves. The growth of neurinomata originating from the posterior roots of the spinal column occurs through the intervertebral foramina, this explaining the characteristic hourglass shape of these neoplasms.

In spite of the variation in the symptoms, a neurinoma may be recognized as such from its location. Anatomically, however, it is very difficult to differentiate from neurofibroma and, under certain conditions, from sarcoma. This is true especially because the larger neurinomata tend to develop cysts in their centers and, like neurofibromata (Recklinghausen's disease), neurinomata may be multiple. The same tumor may show neurinomatous, neurofibromatous, and sarcomatous areas.

In general, neurinomata are to be regarded as benign. If there is any suspicion of sarcoma, the treatment must be radical, but it should be borne in mind that intradural sarcomata are usually benign. In cases of hourglass tumors, the operation should be begun as a laminectomy and continued laterally. In cases of acusticus tumors the operation should be performed in one stage and should not be interrupted if, in the course of its removal, the tumor is discovered to be sarcomatous.

In the discussion of this report, BORCHARDT (Berlin) stated that he had seen nine cases of neurinoma, in three of which the tumor had its origin in the central nervous system. In cases of acusticus tumor he has been using a less radical procedure than was formerly advocated and has thereby improved the prognosis. He called attention to the possibility of the changing of a neurinoma into a neurofibroma or sarcoma. In cases of tumor arising from the peripheral nerve the surgeon must decide whether the tumor should be merely shelled out of the nerve substance or resected with the nerve. About 12 per cent of neurinomata undergo malignant degeneration.

STETTINER (Z).

SURGERY OF THE CHEST

CHEST WALL AND BREAST

Braine, J. F. C., and Massie, G.: Carcinoma Mammæ: The Results of Treatment. *Guy's Hosp. Rep.*, Lond., 1926, lxxvi, 484.

The data upon which the conclusions in this article are based were obtained from the study of 722 cases of cancer of the breast which were treated during the thirteen-year period from 1909 to 1922. The authors' purpose was primarily to determine the results of surgical treatment.

Of eighteen patients not operated upon, seventeen lived thirty-one months after the appearance of the tumor. Of 704 patients subjected to operation, twenty-three died shortly after the operation. Of the 254 patients who died, seventeen had a partial removal of the breast and survived for an average of fifty-three months; sixty-six had an incomplete removal and survived for an average of forty-six months; and 171 had a complete removal and survived for an average of thirty-one months. The authors conclude that in late cases in which there is little possibility of eradicating the disease entirely, the less extensive the operation the longer the patient's survival.

The histological study of the tissue offers little or no aid in the prognosis. Glandular invasion, however, is of considerable significance. Of the patients with involvement of the glands, 45.8 per cent survived for three years and 18.8 per cent for five years. Of those without glandular involvement, 86 per cent survived for three years and 46 per cent for five years.

Of the 338 verified cases, 195 showed metastasis. In 103, the metastases occurred in the skin or a scar; in eighty-six, in glands; in twenty-three, in bones; and in sixty-two, at other sites.

"That more than half of the total number of recurrences should occur in the scar and surrounding skin is surprising and points to an inadequate removal of the superficial tissues at the time of operation."

Of the patients subjected to immediate or prophylactic irradiation, 66 per cent were alive at the end of three years and 31 per cent at the end of five years, while of those not so treated, 50 per cent were alive at the end of three years and 27.3 per cent at the end of five years after the operation.

The chest wall and axilla were divided into five areas and each area was irradiated three times a week for six months or longer. The voltage used was 75 kv., and the skin target distance, 20 cm. A 5-oz. lead skin filter was employed. This superficial irradiation applied immediately after the operation has definitely improved the prognosis.

PAUL W. SWEET, M.D.

Borak, J.: Postoperative Irradiation of Breast Cancer. *Radiology*, 1926, vii, 471.

Postoperative irradiation of breast cancer has been used to a limited extent at the Holzknecht clinic by giving comparatively small doses at intervals over a considerable period of time. The results indicate that it is of definite value. According to investigations made with reference to the cases in which postoperative irradiation was carried out during the years 1919 and 1920, the results have been as follows:

Of twenty-six patients receiving postoperative irradiation in 1919, nine (34 per cent) were still living and free from recurrence in 1926, more than six years after the operation. Of the thirty-seven patients so treated in 1920, seventeen (46 per cent) were well after the lapse of five years. Therefore, of the total number of sixty-three patients, twenty-six (42 per cent) were still living and free from recurrences and metastases after from five to six and a half years. Six patients (10 per cent) had died without any recognizable recurrence of the cancer. The remainder could not be traced.

On comparing the operative results as shown by statistics collected from European and American literature, which reveal an average of 35 per cent of patients living for three years and 25 per cent living for five years without a recurrence, it is evident that the postoperative irradiations brought about an improvement in the results of the radical operation.

The number of cures that can be effected by operation in cases of movable tumor confined to the breast without involvement of the axillary glands is so considerable, provided the operation is radically done, that it is *a priori* improbable that the number would be increased to any appreciable extent by postoperative irradiation.

Postoperative irradiation probably has its greatest field of usefulness in cases which come to operation when the tumor is adherent to the overlying skin and there may be involvement of the axillary glands. In these the operative results are greatly in need of improvement and irradiation has improved them. The results reported from different clinics are cited.

Cases with involvement of the supra-clavicular glands cannot be regarded as particularly suitable for radical operation. They should therefore be considered inoperable and treated only with the roentgen rays or, after an operation that falls short of being radical, should be subjected at first to intensive roentgenization and later to irradiations gradually diminishing in intensity. In any event, the technique for irradiations that is eminently successful for patients undergoing a radical operation

in the second stage does not appear to be so effective in patients who have reached the third stage.

ADOLPH HARTUNG, M.D.

TRACHEA, LUNGS, AND PLEURA

Lemon, W. S.: Bronchiectasis in Childhood. *Med. Clin. N. Am.*, 1926, x, 531.

Between the years 1920 and 1926, 15,500 children under 14 years of age were examined at the Mayo Clinic and a diagnosis of bronchiectasis was made in the cases of sixty-three. Fifty-nine of the cases of bronchiectasis constitute the basis of this report.

The etiological factor was the intrinsic damage due to inflammatory insult. Cases due to stenosis and infection from foreign bodies in the bronchus were not included. In no instance was the cause an extrinsic effect, such as stenosis from the pressure of a malignant growth, aneurism, gumma, or lymphomatous disease.

Twenty-seven patients were males. The youngest was 17 months old and the oldest 14 years. The most common precursors of the bronchiectasis were whooping cough, measles, and disease of the upper respiratory tract, including colds, bronchitis, lobar pneumonia, and bronchopneumonia. The relationship of disease of the nose, throat and accessory sinuses was carefully studied. Bronchiectasis appeared as a primary disease in fully as many cases as sinusitis. In forty-six cases in which the records were complete it seemed that sinusitis was either the cause or the result of the bronchiectasis.

In most cases the symptoms were cough, expectoration, hæmorrhage, and asthenia. The cough was variable, and the character of the sputum depended largely on the pathological changes in the lungs. The most important observation was the frequency of hæmorrhage, 14 per cent of the patients having had more or less bleeding. This percentage is smaller than in adults with the disease. It was found that hæmorrhage might precede the other symptoms of bronchiectasis by many months. Hæmorrhage is much more common in bronchiectasis than in tuberculosis. The most common complications were disease of the upper respiratory tract, pneumonia, pleurisy, empyema and its complications, and abscess. Abscess of the lung was the least common. In one case it acted as the cause of the bronchiectasis, but in two others was the sequel of the existing chronic suppuration. By a study of the nail-fold capillaries an attempt was made to discover the cause of the clubbing of the distal phalanges. This, however, proved fruitless. The roentgenological data showed that in 70 per cent of the cases either definite or suggestive findings corresponded to the clinical signs indicating the degree of damage and the progress of the case.

The general health, height, and weight of the patients were below normal and the pulse and temperature usually above normal. The hæmoglobin and erythrocytes were within normal limits, but the leucocyte count was invariably high.

Smith, D. T.: Experimental Aspiratory Abscess. *Arch. Surg.*, 1927, xiv, 231.

Smith produced pulmonary abscesses in mice, guinea pigs, and rabbits by the intratracheal inoculation of material scraped from the alveolar border of the teeth of patients suffering from moderately severe pyorrhœa.

The same morphological types of organisms were recovered from these experimental abscesses as were found in both postoperative and non-operative pulmonary abscesses in man.

The author concludes that the aspiration of infected material from the teeth and tonsils probably accounts for the greater number of cases of pulmonary abscess, but a small number may result from infected emboli from the upper respiratory passages.

JOHN J. MALONEY, M.D.

Dujarier, C.: Hydatid Cyst of the Left Lung; Extirpation; Closure without Drainage; Recovery (Kyste hydatique du poumon gauche; extirpation. Fermeture sans drainage; guérison). *Bull. et mém. Soc. nat. de chir.*, 1926, lii, 1220.

In a case of hydatid cyst of the left lung physical and X-ray examination revealed an encapsulated accumulation of fluid. Exploratory puncture was followed by a severe anaphylactic reaction with syncope, a urticarial eruption, arthritic pain, and pleuritis.

Operation was performed under general anæsthesia. The pleura was incised and the cyst in the lung exposed. The contents of the cyst were evacuated, the sac was dissected out, and the cavity closed. Recovery was complicated by a febrile course and the development of a pneumohydrothorax which required puncture. Healing finally took place and a subsequent X-ray examination showed only a light lemon-sized shadow marking the site of the pocket from which the cyst had been removed.

LEO M. ZIMMERMAN, M.D.

Sherman, J.: Primary Carcinoma of the Lung. *California & West. Med.*, 1927, xxvi, 40.

Metastases in the mediastinum from extrathoracic carcinoma are not rare, but primary carcinoma of the lungs is uncommon. In a study of the symptoms produced by the latter condition, the author reviewed over 600 cases. He reports two cases in detail.

Early diagnosis is difficult because the symptoms produced by the carcinoma closely simulate those produced by tuberculosis, influenza, and cardiorenal, cardiac, and other conditions.

Primary pulmonary carcinoma may arise from: (1) the epithelial lining of the bronchial mucosa, (2) the mucous glands, or (3) the epithelium lining the alveoli. Ewing classifies the alveolar type into: (1) the diffuse, and (2) the nodular.

The symptoms are discussed in detail. No sign diagnostic of the condition in its incipiency has been noted. The later stages are associated with hoarseness and laryngeal cough produced by paralysis of the recurrent laryngeal nerve. The condition is

recognized earlier by bronchoscopy than by X-ray examination. The treatment suggested is cauterization, which is the one method by which the pain may be relieved. Radium and the X-rays are of no a vail.

PAUL W. SWEET, M.D.

Jackson, B. H.: The X-Ray Diagnosis of Empyema. *Atlantic M. J.*, 1926, xxx, 135.

Jackson, C.: The Bronchoscope as an Aid in the Diagnosis and Treatment of Pulmonary Infections. *Atlantic M. J.*, 1926, xxx, 139.

Butler, E. F.: The Surgical Management of Empyema. *Atlantic M. J.*, 1926, xxx, 142.

B. H. JACKSON describes the normal appearance of the thorax and its contents, discusses the differential diagnosis of chest lesions as shown by the X-ray, and explains the upward curve of the fluid line in partial effusions.

It is impossible to make a diagnosis of empyema by X-ray methods alone. Fluid can be demonstrated in the pleural cavities roentgenologically, but purulent, serous, sanguineous, and serofibrinous pleuritic effusions cannot be differentiated.

A diagnosis should never be made at once from fluoroscopy alone. The roentgenological findings must always be considered with all other clinical data obtainable. The clinician and roentgenologist should work in conjunction and correlate their findings.

C. JACKSON summarizes the advantages of bronchoscopy in pulmonary infections as follows:

1. The interior of the lung may be inspected safely.

2. The orifice of the bronchus leading to any one of the five lobes can be quickly identified and any abnormality in the lumen, mucosa, or secretions thereof can be determined.

3. Any departure from the normal in the secretions, the mucosa, the lumen, or the form and movement of the bronchial walls can be noted with all the certainty of direct vision.

4. Obstructing masses of secretion can be removed and the subjacent bronchi, fistulæ, or cavities explored.

5. Specimens of tissue and uncontaminated specimens of secretions can be removed with precision.

6. The presence or absence of lesions can be determined not merely with regard to the right or left lung, but with the utmost precision of localization as to lobes and, except in infants, to portions of lobes.

7. Pneumonograms furnishing accurate, localized, and graphic data of the utmost diagnostic value can be made of any particular region. Bronchoscopic inspection reveals the pathological area into which bismuth subcarbonate or lipiodol are to be introduced. If obstruction is present, it can be dealt with bronchoscopically so that the distal region can be reached with the opaque material.

8. In diagnosis, not only the direct information but also the indirect information yielded by the bronchoscope is helpful.

9. All of the diagnostic information mentioned may be obtained in the case of any patient whose mouth can be opened.

10. Anæsthesia is unnecessary, but in the cases of adults local anæsthesia may be induced if desired.

Diagnostic bronchoscopy in pulmonary abscess, bronchiectasis, and tuberculosis is discussed together with its indications and contra-indications.

The bronchoscopic treatment of lung suppuration following tonsillectomy, residual suppuration, empyema, bronchial stenosis, benign growths of the lung, and malignant disease of the lung is described.

BUTLER, discussing the surgical treatment of empyema, deals more with the fundamental principles than with special technical points.

The effect exerted by drainage operations on vital capacity depends upon the presence or absence of adhesions between the visceral and parietal layers of pleura. Of great importance is the fact that the pleura reacts differently to the various organisms which are commonly encountered in post-pneumonic empyema.

The danger to life demands conservatism in the initial approach, but when once this risk begins to decrease, two other risks loom large, that of chronicity and that of recurrence. Conservatism does not meet the requirements here; radicalism is more effective.

Irrigation with antiseptics and continuous suction are valuable procedures, one bringing chemical aid and the other mechanical aid. However, the problem is surgical. Obliteration of the cavity may become necessary.

In conclusion, Butler says it is necessary to study each case of empyema as an individual problem, to discover the etiological factors, the responsible organism, and the site of the cavity, and to know all that can be learned about pleural adhesions. When the danger to life is great, the surgeon should be cautious, but as this risk decreases he should become bold.

CARL R. STEINKE, M.D.

HEART AND PERICARDIUM

Pribram: The Operative Treatment of Mitral Stenosis (Operative Behandlung der Mitralstenose). *50 Tag. d. deutsch. Ges. f. Chir.*, Berlin, 1926.

Pribram reports the case of a 38-year-old woman who, twenty-three years previously, suffered an attack of articular rheumatism and thereafter developed symptoms of mitral stenosis. Kraus, whom the patient consulted first, was of the opinion that there was no possibility of improvement under medical treatment and that the prognosis was hopeless. The patient therefore concluded to submit to operation.

The operation was performed under ether anæsthesia. A longitudinal incision was made over the sternum with resection of the costal cartilages. The sternum was divided in the midline down to the xiphoid process and the two sections were separated

and held apart. The mediastinal pleura was pushed out of the field. A slight tear which occurred was immediately repaired by suture. The pericardium was then split and the left ventricle fixed by two anchoring sutures. The punch-like instrument was then introduced into the left ventricle through the muscular wall which closed about its rounded stem and allowed hardly any bleeding. Guided by the fingers, the instrument was then brought up against the stenotic tissue of the mitral valve and a hole was punched through. The instrument was then immediately withdrawn, the wound in the heart closed, and the external wound sutured.

A change in the heart was noted at once. The stenosis was changed into an insufficiency. A presystolic murmur began. The blood pressure, which had been previously very low (90), rose to 150. The general condition was good. On the third day fever began. By the fifth day the temperature had risen to 40 degrees C., and on the sixth day the patient died. Autopsy revealed as the cause of death an aortic endocarditis. There was no sign of a recent endocarditic process on the mitral valve.

This case demonstrates that the operation described may be performed successfully, but should be undertaken only when there is no possibility of an endocarditic process.

In the discussion of this report, KOERTE stated that he doubted whether any benefit was to be derived from the changing of a stenosis into an insufficiency. Pribram replied that in his opinion the prognosis of insufficiency is more favorable than that of stenosis.

SCHOENBAUER reported that in a recent trip to America he had the opportunity to see four cardiac operations. Of the four patients, only one, a girl of 16 years, survived. He believes that patients with aortic stenosis are more favorable subjects for the operation than those with mitral stenosis. In mitral stenosis the musculature of the left ventricle, upon which is thrown the increased burden created by the insufficiency, is atrophic and it is questionable whether in the majority of cases it will respond to the new requirements. In aortic stenosis, on the other hand, the musculature is hypertrophic and will therefore respond more easily to increased demands upon it. STETTINER (Z).

ŒSOPHAGUS AND MEDIASTINUM

Clerf, L. H.: Foreign Bodies in the Œsophagus. *Ann. Otol., Rhinol. & Laryngol.*, 1926, xxxv, 1000.

The author reports cases illustrating the chief points in the etiology, symptomatology, diagnosis, and treatment of foreign body in the œsophagus.

A history of coughing, gagging, or choking when an object was held in the mouth is always suggestive of foreign body especially in the cases of children playing on the floor.

A negative roentgenological opinion of opaque foreign body in the alimentary canal cannot be given unless the studies include the entire food tract from the nasopharynx to and including the tuberosities of the ischium. After the removal of one object, multiplicity of foreign bodies should be ruled out by roentgenography.

The regurgitation caused by a foreign body in the œsophagus is frequently regarded as vomiting and often leads to a diagnosis of gastric disturbance.

Non-opaque foreign bodies can be diagnosed roentgenologically only after the injection of opaque material. Such injections should be made whenever the symptoms are suggestive and the first roentgenograms are negative.

Difficulty in swallowing is the most common symptom of œsophageal disease.

The passage of a bougie into the stomach does not rule out foreign body in the œsophagus.

Inability to swallow saliva and the presence of pyriform sinuses filled with secretion indicate complete œsophageal stenosis.

Pain may be produced by the impaction of a large object in the œsophagus, penetration of the œsophageal wall, or secondary inflammation. It cannot be relied upon to localize the obstruction.

Œsophageal foreign bodies may not only interfere with swallowing but also, because of their shape, size, or nature, may give rise to signs and symptoms referable to the air passages. In one of the author's cases dyspnœa was an alarming symptom.

When tacks or other small foreign bodies lodge in the œsophagus, penetration of the œsophageal wall usually occurs with a variable degree of periœsophageal infection.

The prolonged sojourn in the œsophagus of large irregularly shaped objects may lead to tissue destruction, ulceration, and perforation.

Immediately after the removal of a foreign body the swallowing function should be tested.

The persistence of symptoms referable to the œsophagus in the presence of negative roentgen-ray findings calls for a diagnostic œsophagoscopy.

JEROME R. HEAD, M.D.

Manges, W. F.: Roentgen Diagnosis of Foreign Bodies in the Œsophagus. *Am. J. Roentgenol.*, 1927, xvii, 44.

Foreign bodies lodge in the œsophagus because they are too large to pass, because they become embedded in the mucous membrane, or because the œsophageal lumen is narrowed. In some cases they may perforate and project into the peri-œsophageal tissues.

Large foreign bodies causing complete or partial obstruction are more common in children than in adults, whereas small slender foreign bodies which become embedded are more common in adults. The most common large foreign body is a coin, and the most common small embedded foreign body a small fragment of bone. The perforating foreign body is very rare. In cases of stricture the cause is most often a piece of meat. The most common location for all œsophageal foreign bodies to lodge is at or just below the level of the suprasternal notch.

In the roentgenological examination, the following should be insisted upon: (1) the removal of all clothing, (2) examination of the entire tract from the nasopharynx to the anus, (3) exposures made in both the anteroposterior and the lateral position, and (4) the best quality of roentgenograms.

To determine the site of the large, non-opaque foreign body, a fairly thick, watery mixture of bismuth subcarbonate should be used to show either a filling defect or a deviation of the stream. In examination for the small, slender, non-opaque foreign body that becomes embedded, the patient should be made to swallow a wet No. oo capsule filled with bismuth subcarbonate. When there is a history of the swallowing of glass, it is unwise to use capsules or any hard substance. The greatest width of œsophageal foreign bodies is in the lateral direction, while that of the tracheal foreign body is in the anteroposterior direction.

The complications and sequelæ that may arise from foreign bodies in the œsophagus are: (1) acute hunger and thirst, (2) the aspiration of particles of food into the trachea with subsequent pulmonary infection, (3) injury to the œsophageal wall with subsequent stricture, and (4) peri-œsophageal infection. CHARLES H. HEACOCK, M.D.

Rovsing, T.: The Technique of My Method of Antethoracic Œsophagoplasty. *Surg., Gynec., & Obst.*, 1926, xliii, 781.

Rovsing discusses the various œsophagoplastic methods used for the past twenty years, all of which are based on the conviction that the new gullet must be capable of peristaltic motion. In his opinion, peristalsis is not necessary as, in most successful cases, if it is present at all, it very rapidly ceases, whether the new œsophagus was formed from the jejunum, the colon, or the stomach. Moreover, Gluck and Torek's cases have shown that a simple rubber drain uniting an œsophagostomy with a gastrostomy will function satisfactorily for many years. These considerations led Rovsing to work out a simple and less dangerous skin plastic method which he has employed successfully in four cases. The operation is done in four stages.

First stage: Gastrostomy. The small portion of the anterior wall of stomach that is used is drawn up through an opening in the left rectus muscle and an opening of a size to admit the largest Pezzer drain is made. The button of the drain is fastened tightly to the anterior wall of the stomach.

Second stage: Œsophagostomy. This is performed through an oblique incision along the sternomastoid. The œsophagus is freed, brought up to the skin incision, and cut between clamps, the inferior end then being brought out through a small incision in the left supraclavicular fossa, fixed to the skin, and drained with a tight rubber drain. The oral œsphageal end is sutured to the lower part of the oblique incision, and a rubber tube is introduced into the œsophagus from the mouth and led out through the œsophagostomy.

Third stage: The formation of the new œsophagus. Two parallel skin incisions are made, the distance between them being the circumference of the new organ, and the skin is dissected inward so that it can be united in the midline around a drain. The drain is later removed. The two skin incisions meet above the œsophagostomy at the upper end, while at the lower end they correspond to the plane of the gastrostomy but do not meet around it as the gastrostomy must be kept open until the upper part of the antethoracic œsophagus is entirely healed. The œsophageal drain is brought down into a low-placed glass receptacle.

Fourth stage: When the wound is well-healed, the Pezzer drain and the œsophageal drain are removed, the gastrostomy is closed, and the two parallel incisions are extended to meet each other around the œsophagostomy.

JACOB M. MORA, M.D.

Lerche, W.: Infected Mediastinal Lymph Nodes as a Source of Mediastinitis. *Arch. Surg.*, 1927, xiv, 285.

The tracheobronchial lymph nodes, which receive lymphatics from the lungs and bronchi and the lower trachea and its bifurcation, are very important as germ-harboring depots. An abscess of these nodes may discharge into a bronchus with subsequent healing, but a number of autopsies have revealed rupture into one of the large blood vessels or into the heart and other mediastinal organs.

The proper diagnosis and treatment are dependent upon an accurate knowledge of the topography of the various groups of lymph nodes and the surrounding organs. These nodes consist of three main groups, situated in the right, the left, and the inferior tracheobronchial spaces, as described by Sukiennikow. Cases with involvement of each of these spaces are reported with anatomical sketches and roentgenograms. The symptoms consisted as a rule of a dry cough and a substernal pain which was increased by deep breathing and swallowing. Pressure upon the recurrent nerve and the œsophagus caused hoarseness and dysphagia.

The author reports also a case in which inflammation of the eparterial lymph nodes led to compression of the eparterial bronchus. In another case the abscess ruptured through the œsophagus, leaving a fistulous opening through which applications could be made to the mediastinal abscess cavity.

As the left phrenic nerve is in close proximity to the pre-aortic group of lymph nodes, the author believes that the periadenitis often involves this nerve with resulting insufficiency of the corresponding side of the diaphragm.

These inflammations are attributed largely to influenzal and tuberculous infections, but a case due to a streptococcus infection has been reported. Subdiaphragmatic infections following appendectomy may give rise to mediastinal gland involvement as the mediastinal glands receive lymph from the liver and diaphragm. Also, in the majority of cases, the

lymph vessels of the falciform ligament of the liver drain to the mediastinal glands.

The bronchoscope and the œsophagoscope are of great aid in the diagnosis and treatment of these cases. The author advocates mediastinotomy as soon as a positive diagnosis of mediastinal abscess is made. GEORGE A. COLLETT, M.D.

MISCELLANEOUS

Burrell, L. S. T., Roberts, J. E. H., Hastings, S., Melville, S., and Others: The Diagnosis and Treatment of Intrathoracic New Growths. *Proc. Roy. Soc. Med.*, Lond., 1926, xx, 151.

This article is a symposium by physicians, surgeons, laryngologists, and roentgenologists. The fact is emphasized that for efficient diagnosis and treatment these specialists must work together.

BURRELL presents a classification of intrathoracic neoplasms and cites cases illustrating the symptoms and signs. Primary mediastinal growths include sarcoma, Hodgkin's disease, fibroma, and dermoid. The first signs are those of pressure. In one case the first signs included hypertrophic osteoarthropathy. Dyspnœa and pain are common early symptoms, but may develop only in the later stages.

Endothelioma of the pleura causes pain and a rapidly recurring but not always bloody effusion.

Carcinoma of the lung is more common than was formerly believed. It is rarely recognized, being frequently mistaken for pulmonary tuberculosis. Tuberculosis and other chronic pulmonary conditions predispose to it. It is usually of bronchial origin, and its first symptoms are cough, sputum, and hæmoptysis. The late symptoms are those of sepsis secondary to bronchial obstruction.

Burrell emphasizes the importance of early diagnosis of intrathoracic new growths.

ROBERTS, speaking of the surgical treatment, says that surgery is suitable only for benign mediastinal growths. For those in the lower part of the mediastinum he advises a long intercostal incision, and for those higher up, a splitting of the sternum. Malignant growths are best treated with the X-ray or radium.

Primary bronchogenic carcinoma, if diagnosed sufficiently early, can be removed with the bronchoscope.

HASTINGS, discussing the subject from the point of view of the laryngologist, speaks of the recurrent nerve paralysis and compression of the trachea caused by mediastinal growths and of the diagnostic and therapeutic value of bronchoscopy in cases of primary tumor of the trachea and bronchi.

MELVILLE, dealing with the X-ray aspects of intrathoracic tumors, emphasizes the increased incidence of the neoplasms under discussion. He cites statistics showing that carcinomata of the lung constitute 6 per cent of all primary carcinomata.

Fibroma of the mediastinum presents a well-defined rounded opacity springing from the posterior part of the thoracic wall and pushing the lung in front of it. Collapsing the lung from in front of the tumor by artificial pneumothorax is important in the diagnosis.

Dermoid cysts usually arise in the anterior mediastinum. Occasionally it is possible to see fragments of bone or teeth in their contents.

The first sign of bronchogenic carcinoma is usually a typical massive collapse caused by obstruction of the bronchus. Later, parenchymal and pleural sepsis frequently obscure the picture.

Malignant metastases in the lung present a typical picture. It is impossible to distinguish between sarcomatous and carcinomatous metastases.

The roentgenological diagnosis of mediastinal new growths requires care and often an elaborate technique, including oblique and lateral views and the injection of bismuth into the œsophagus or the injection of lipiodol into the bronchi. It is important to determine that the mass is not connected with the aorta or lung and that it is not thyroid.

KNOX, discussing radiotherapy, emphasizes first the importance of accurate diagnosis, preferably by biopsy. If this is impossible, the results of therapy will often suggest the type of tumor. The benign growths and carcinoma rarely respond. Lymphogenic and sarcomatous tumors are rapidly affected. The greater part of Knox's discussion deals with the technique of radiotherapy. JEROME R. HEAD, M.D.

SURGERY OF THE ABDOMEN

ABDOMINAL WALL AND PERITONEUM

Forlini, E.: The Retroperitoneal Fossæ and Treitz' Hernia (Contributo alla conoscenza delle cosidette fosette retroperitoneali e delle ernie del Treitz). *Arch. ital. di chir.*, 1926, xvi, 481.

The author describes the anatomy of the retroperitoneal fossæ, including the intersigmoid, superior ileocæcal, inferior ileocæcal or ileo-appendicular, subcæcal, duodenojejunal, and superior and inferior duodenal fossæ, and describes the anatomical findings in five cases of Treitz' hernia.

The first case was that of a soldier who was taken with severe diarrhœa and vomiting while in the trenches. Cholera was suspected. The patient was sent to the hospital and soon died. Autopsy showed the large omentum to be normal and free. Beneath it was a packet of small intestine which, instead of being free, was contained in a properitoneal bursa constituting the ordinary form of Treitz' hernia. It was a large sac containing all of the small intestine which was continuous with the posterior wall of the abdomen and surrounded on the sides and above by the colon. It was formed of a transparent membrane through which the loops of small intestine could be seen clearly. The opening into the sac was through an oval fenestra about 8 by 6 cm. in size, situated beneath the point where the duodenum passes into the jejunum, just at the right of the spinal column. The opening was toward the right. There was a partial post-inflammatory adhesion of the ileum and mesentery to the postero-inferior margin of the opening, so that the intestine could not be withdrawn as it usually can be in Treitz' hernia. There was also a torsion of the mesentery which persisted even after the mesentery was freed.

Case 2 was that of a man 72 years of age who was in the hospital for six days with intense pain in the abdomen, continuous vomiting, and the passage of numerous scanty liquid stools. At autopsy, the small intestine from the duodenum to the middle of the ileum was found in the sac of a Treitz hernia, the opening of which was beneath the transverse colon. The end of the ileum, the cæcum, and the right part of the colon had descended by invagination into the left part of the transverse and descending colon to within 1 cm. of the anus. There was an inguinal hernia on each side, and the one on the left side contained the ectopic testicle. There was a purulent exudate on the parietal and visceral peritoneum. The diagnosis was suppurative peritonitis following intestinal invagination in a subject with a Treitz hernia.

The third case was that of a child 4 years of age who died of tuberculous meningitis. Autopsy showed a sac the size of a child's head in front of the left kidney with the descending colon running above. The sigmoid described a curve, bounding the sac below and on the left. The cæcum bounded it to the right and below. The transverse mesocolon was completely free, while the right fold of the descending mesocolon covered the sac so that it looked as if the sac were formed of the fold itself. The sac contained almost all of the jejunum; it had an oval opening about 4 by 5 cm. in diameter beneath the transverse colon.

Case 4 was that of a woman of 90 years who died after fracture of the hip. Autopsy showed the large intestine to be normal in position but distended with gas. The small intestine was in a sac formed of peritoneum surrounded above and at the sides by the colon. The sac was the size of a child's head and situated entirely in the left side of the abdomen. It was implanted by a small base which looked like a pedicle. The superior mesenteric vein ran in the upper lip of the sac which lay beneath the transverse colon to the left of the vertebral column in the usual position of the left duodenal fossa.

Case 5 was that of a woman about 50 years of age. At autopsy almost all of the small intestine was found in a sac which had an opening beneath the transverse colon. The colon had been pushed to one side and upward so that it surrounded the sac containing the small intestine.

These cases present the usual picture of Treitz, hernia. While the literature says that the incidence of the Treitz and Broesiche herniæ is about equal and both types are twice as frequent in males as females, all of these cases were cases of the Treitz type and three of the patients were females. Two of the herniæ occupied the whole abdominal cavity and were surrounded by large intestine. The others were not complete and contained parts of the small intestine. One had a large sac with a small base directed from above downward and was free, that is to say, it seemed to be formed chiefly of posterior parietal peritoneum with little involvement of the descending mesocolon. In the two others the sac was situated almost completely beneath the descending colon, in one of them high up toward the splenic flexure. These various relations of the sac to the descending mesocolon depend on the greater or less resistance offered by the various regions of the retroperitoneal connective tissue to the distention of the walls of the sac and the consequent detachment of the peritoneum from the posterior wall of the abdomen.

The posterior parietal peritoneum does not adhere to a smooth surface as does that of the anterior wall, but passes over various organs, large vessels, nerves, pancreas, kidneys, etc., forming depressions in which there is an abundance of fat and the retroperitoneal

connective tissue is looser so that slight traction easily causes detachment at these points. Detachment is easier on the left side than on the right, and varies in different persons. The herniating intestine follows the line of least resistance, this explaining the different positions in the different cases. In the third case, besides the portal of entry, there was another fossa corresponding to the duodenojejunal fossa. Apparently the opening of the hernia was in the left duodenal fossa bounded by the inferior mesenteric vein and the other fossa was the coexisting dudodenojejunal fossa.

Some of these cases, such as the second one in which, in addition to the Treitz hernia, there was a double inguinal hernia, seem to indicate a congenital origin of these heniæ. Congenital predisposition is indicated also by the cases in which large fossæ have been found without penetration of intestine.

AUDREY G. MORGAN, M.D.

Cornioley, M.: Mesenteric Cysts (Contribution à l'étude des kystes mésenteriques). *Lyon chir.*, 1926, xxxiii, 566.

There has been a great deal of confusion in the classification of mesenteric cysts because it has been made partly from the clinical and partly from the pathologico-anatomical point of view. The author suggests a separate clinical and pathologico-anatomical classification. Clinically the cysts may be divided into retroperitoneal cysts and pure mesenteric cysts with subdivision of the latter into cysts of the meso-appendix, the mesentery, and the mesocolon. The pathologico-anatomical classification is as follows: (1) cysts from retention in the lymphatic vessels, which are subdivided into chylous, serous, hæmorrhagic, and purulent cysts; (2) cysts from the degeneration of lymphatic glands with the same subdivisions; (3) cystic lymphangiomata of the mesentery, also with the same subdivisions and called "chylangiomata" when their contents are chylous; (4) congenital cysts, dermoid or entodermoid; (5) dermoid cysts, teratoid and mixed; (6) enterocystomata; and (7) parasitic cysts.

Cornioley reports two cases, one that of a woman of 35 years and one that of a woman of 43 years. While these two cysts would ordinarily be classified as cysts of the mesentery, the first was really a retroperitoneal enterocystoma and the second a cystic chylangioma of the mesentery.

The first symptoms are rather vague intestinal symptoms, loss of appetite, and diarrhœa followed by constipation. The cyst may develop for some time without causing any symptoms at all. Then acute symptoms may begin suddenly, due to occlusion of the intestine rather than to the cyst itself. In the author's cases there was distention of the abdomen with pain, uncontrollable bilious vomiting, abdominal facies, and a rapid pulse but no fever.

Often when there is no palpable tumor a diagnosis of volvulus is made. Volvulus often occurs in cases of mesenteric cysts, though the occlusion may be due to compression of a loop of intestine. A mesenteric cyst is movable and can readily cause volvulus, while a retroperitoneal cyst must be quite large before it can compress a loop of intestine between itself and the anterior wall of the abdomen. The latter occurred beyond doubt in the author's first case and in a case reported by Wildbolz. In the author's case it was the ascending colon that was compressed, and in Wildbolz' the transverse colon. Generally the occlusion is not total; therefore operation may be deferred for hours or even for days. This is explained by the fact that often a volvulus is one of only 90 instead of 180 degrees.

A symptom often noted by the patient is intra-abdominal ballottement on flexion and extension of the trunk. This is of value in the localization of the tumor. A symptom present in all cases of mesenteric cyst that have been reported was a reflex contracture of the abdominal wall during periods of subacute crisis. As a peritoneal reaction has seldom been found at operation, the author thinks this is due to traction on the cœliac plexus by the weight of the cyst.

The percussion sounds vary, depending on whether the cyst is covered by intestine or not. Mesenteric cysts are generally smooth and oval, a fact which makes it possible to distinguish them from cancers of the intestine which are generally nodular. The diagnosis of mesenteric cysts which are movable is not particularly difficult, but it may be impossible to distinguish fixed retroperitoneal cysts from tumors of the pancreas, spleen, or liver. It is important to make this differentiation because some of these organ cysts cannot be extirpated on account of adhesions to the organ from which they originate.

When a cyst suppurates, which is quite rare, the symptoms of peritonitis may mask those of the cyst itself. Cysts have been known to rupture without suppuration, causing a chylous or serous peritonitis, the cause of which is rarely diagnosed.

The treatment is removal of the cyst unless it is extremely large or the general condition is very poor. If the loop of intestine with which the cyst is connected has suffered serious injury or if the mesenteric vessels of the segment are in poor condition, the loop should be removed with the cyst. Marsupialization is not justifiable except in such cases. These cysts rarely recur.

AUDREY G. MORGAN, M.D.

GASTRO-INTESTINAL TRACT

Faber, K., Holst, J. E., and Norgaard, A.: An Investigation of the Function of the Stomach by Fractional Removal of the Test Meal. *Acta med. Scand.*, 1926, lxiv, 570.

Fractional examinations of the gastric contents were made by the authors eighty-three times after an oatmeal porridge meal and seventy-six times after a rusk meal. The conditions studied were chiefly digestive disturbances.

In seventy-nine tests the amount of the fasting secretion was 20 c.cm., and in four tests, 100 c.cm.

or more. As a rule the quantity of secretion was large when the maximum acidity in the subsequent test meal was high. In the same cases the acidity of the secretion was high. A low acidity in amounts of secretion of 20 c.cm. or less has no clinical significance.

The acidity curves in the fractional withdrawal of the test meal in different patients are reproduced.

The time of greatest acidity (expressed as the Congo-red figure) was most frequently found from one to one and a half hours after the ingestion of the test meal, earlier with low acidity and later with high acidity.

As a rule the Congo-red values after one hour are an expression of the highest values of the acidity curve.

True achylia must be distinguished from false achylia. The latter can be detected by fractional examination. A phenolphthalein figure above 25 and high pepsin values in an Ewald test meal which does not react to Congo-red paper indicate false achylia.

On account of the regurgitation of the alkaline duodenal contents, the stomach contents may acquire, once or more frequently during digestion, a hydrogen-ion concentration which is below that at which pepsin is active and the Congo-red reaction is positive.

The regurgitation of the duodenal contents is most often observed toward the end of gastric digestion. It is just as common in anacid as in hyperacid test meals and is therefore not a characteristic of the latter.

On investigation with the iodine test, starch was usually found to disappear from the stomach from two to two and a half hours after the ingestion of an oatmeal porridge meal and in from two and a half to two and three-fourths hours after the ingestion of a rusk meal. Emptying proceeds more slowly the greater the acidity of the test meal.

In sixteen cases of achylia, a rusk meal usually left the stomach within nine and five-tenths hours after its ingestion.

A comparison between the acid figures in Ewald's test meal and in the corresponding fractional investigation showed that the former gave a satisfactory indication of the maximum acidity of the latter.

In daily clinical work, Ewald's test meal will suffice, for the present, for investigations of the hydrochloric acid secretion of the stomach. The fractional examination will be necessary in only special cases.

Andresen, A. F. R.: Fractional Gastric Analysis with Histamine. *Ann. Clin. Med.*, 1926, v, 472.

Although fractional gastric analysis is time-consuming, it is of great diagnostic value. A water test meal is not efficient as it too often shows achylia. The author therefore uses histamine dihydrochloride hypodermically to stimulate gastric secretion. This procedure is not attended by any untoward symptoms, and the results obtained from the substitution of hypodermatic injections of histamine and a 300 c.cm. water meal for the usual cracker and water meal have been eminently satisfactory. Nearly 300 cases have been tested in this manner.

The curves of acidity are not to be considered the most important factors in fractional gastric analysis. About the only factors of diagnostic importance are the motor efficiency of the stomach and a study and comparison of admixtures found in the removed specimen.

The author describes in detail the technique he uses. In addition to titration, specimens are examined microscopically for raisin residue, gross blood or pus, or other admixtures. The different findings and curves are explained, and various diseases with their findings are cited.

At the completion of the test, with the patient lying down and the abdomen exposed, the stomach is inflated through the tube and the size and shape of the stomach and the location of the greater curvature are noted. This is often a more reliable method than X-ray examination.

HERMAN H. HUBER, M.D.

Keefer, C. S., and Bloomfield, A. L.: The Significance of Gastric Anacidity. *Bull. Johns Hopkins Hosp.*, Balt., 1926, xxxix, 304.

There is no definite correlation between the degree of acid secretion and physical fitness. Approximately one of twenty normal persons has a deficient gastric secretion.

The authors' observations were made in a study of consecutive gastric analyses in the medical wards of the Johns Hopkins Hospital, Baltimore. In 1,500 analyses, anacidity was found in 390 (26 per cent). The diagnosis was based in each case on the absence of free hydrochloric acid in the gastric contents from forty-five minutes to one hour after the ingestion of the Ewald test meal. However, the determination of the pH of the gastric contents shows that this test lacks refinement. Many persons with apparent anacidity are able to secrete acid. When the histamine test is applied, the incidence of anacidity is still further reduced and becomes practically limited to persons with definite anatomical disease of the stomach such as cancer and the gastritis of pernicious anæmia.

The material studied was classified as follows: (1) patients with digestive disorders; (2) those with various diseases not primarily of the digestive tract; and (3) those with no evidence of anatomical disease.

The frequency of anacidity increases with age, whether organic disease is present or not. The investigation yielded no definite evidence for the assumption that diseases other than disease of the stomach in themselves influence the occurrence of anacidity. The authors found no evidence that anacidity *per se* causes any specific symptoms or signs; in brief, they were unable to discover any definite correlation between anacidity and any other factor except age.

With regard to gastric motility the generalization is made that stomachs of the anacidity group empty more quickly than those of the normal acidity group.

CHARLES F. DUBOIS, M.D.

Baggio, G.: Experimental Gastric Ulcer from Obstruction to the Emptying of the Stomach (Ulcere gastriche sperimentali da ostacolo allo svuotamento dello stomaco). *Policlin.*, Rome, 1926, xxxiii, sez. chir., 437.

The author performed experiments on animals to determine the cause of ulcer of the stomach and duodenum. He operated on ten animals, folding in the anterior wall of the stomach and fixing the introflexion with catgut sutures. The posterior wall was not touched at all, and the introflexions were never deep enough to obstruct the lumen of the stomach completely. The trauma from the operation was very slight.

Six of the animals died after intervals ranging from four to fifty-four days and the four others were killed at the end of three months. The four that were killed and one of the animals that died after fourteen days did not show any signs of ulcer, but the others showed lesions varying from simple erosion to an advanced stage of typical gastric ulcer.

The lesions were not only on the introflexed wall, but also, in some cases, on the posterior wall opposite the introflexion. They were always in zones connected functionally with the folded-in part. The recent lesions were associated with extravasations of blood into the walls of the stomach.

Baggio believes the ulcers were due to the traumatic action of the ingesta on the stomach wall as a result of the increased intragastric pressure from the obstruction caused by the introflexions. This trauma favored the digestion of the wall by the gastric juice.

AUDREY G. MORGAN, M.D.

Lahey, F. H., and Jordan, S. M.: When To Operate in Cases of Peptic Ulcer. *N. York State J. M.*, 1927, xxvii, 60.

Lahey and Jordan are attempting to teach patients to manage their gastric ulcers by diet and medical measures. They believe that surgery is not the primary method of treatment, and that, because of the recurrence of ulcer and the mortality of operation, it becomes the duty of the surgeon who accepts an ulcer case regarded as a "medical failure" to be highly critical of that medical treatment and before suggesting surgery to try medical management. The course of treatment advocated should be of known thoroughness both in outline and in applicability on the part of the patient.

They regard operation as indicated for: (1) perforated ulcers; (2) ulcers with unrelievable cicatricial obstruction; (3) cases of recurrent severe hæmorrhage; (4) cases in which carcinoma can be reasonably suspected; and (5) cases of failure with well known adequate medical management.

MORRIS H. KAHN, M.D.

Finney, J. M. T.: The Surgery of Gastric and Duodenal Ulcer. *Am. J. Surg.*, 1926, i, 323.

Finney gives a brief review of our former knowledge of gastric and duodenal ulcer. He states that the two extremes—consistent opposition to any form of operation and the indiscriminate resection of large portions of stomach wall—are to be avoided. The middle course—a conservative type of operation—is followed by the large majority of surgeons of experience.

The diagnosis of gastric and duodenal ulcer is based on the careful accumulation and interpretation of information derived from many sources. Close co-operation between the internist and the surgeon is essential.

Cicatricial contraction in healing, perforation, and hæmorrhage are complications of importance to the surgeon in the selection of the type of operation to be performed or other treatment to be given.

The theories advanced as to the origin of gastric and duodenal ulcers include the inflammatory, neurogenic, circulatory, bacterial, digestive, and corrosive theories. In all probability, chronic ulcer of the stomach or duodenum is due, not to a single cause acting alone, but to a combination of causes acting more or less together. That ulcer of the stomach may be the origin of carcinoma seems definitely established. The work of Cabot and Adie and of Williams and Ewing is very enlightening. According to Wilson and MacCarty, 68 per cent of ulcers develop secondary carcinoma. In Finney's opinion, only from 10 to 15 per cent of gastric ulcers undergo carcinomatous transformation. Consequently, the surgeon's method of procedure—radical or conservative—will depend upon which view he accepts and whether the lesion found appears to be a simple ulcer or a precancerous ulcer.

The conservative operations may be divided into: (1) those directed toward local excision, cauterization, or suture of the ulcer, and (2) local excision with gastro-enterostomy or pyloroplasty alone. In a radical operation, not only the ulcer but the entire ulcer-bearing area described by Rodman must be removed (gastrectomy by the Billroth I or II method).

Of course, the choice of operation should depend entirely upon the patient's condition. In Finney's opinion, pyloroplasty or gastroduodenostomy associated, when possible, with resection of the ulcer would be the procedure of choice. Extensive resection of the stomach is reserved almost entirely for malignant disease.

The sacrifice of large portions of the stomach is too great a risk to be assumed by the average surgeon.

The surgeon should be guided entirely by the facts established and the circumstances found. If, for any reason, a more or less extensive resection of the pyloric portion of the stomach is indicated, gastroduodenostomy (Billroth I, Haberer-Finney modification) should be done.

HERMAN H. HUBER, M.D.

Flint, E. R.: Gastroduodenostomy. *Lancet*, 1927, ccxii, 12.

Flint has treated nearly 200 cases of chronic duodenal ulcer by gastroduodenostomy. In the technique of the operation the angle between the second and third parts of the duodenum should be freed rather than the upper angle where the first and second parts meet, as at this point there are many vessels. Flint does not use a clamp on the duodenum and does not insert any stitches in the gastric mucosa. Omission of the duodenal clamp allows digital palpation of the ulcer. The ulcer is sutured over. A complete block caused by the stitches has never been found in the author's cases. As the duodenum is very irritable, Flint believes that its handling accounts for the postoperative vomiting.

After the operation, glucose solution is given by rectum in the author's cases and nothing is allowed by mouth for a period of from twenty-four to forty-eight hours.

There have been two deaths, both those of patients who were emaciated before the operation. There has been no anastomotic ulcer. Should such an ulcer develop, it is still possible to perform a posterior gastro-enterostomy.

J. Frank Doughty, M.D.

Troell, A.: Benign Tumors of the Stomach, Especially from the Point of View of Diagnosis (Les tumeurs benignes de l'estomac au point de vue surtout diagnostique). *Acta radiol.*, 1926, vii, 568.

Fairly numerous cases confirm the theory that the roentgenological finding of a sharply defined, rounded, mobile filling defect in the stomach shadow after the ingestion of an ordinary opaque meal is practically pathognomonic of a benign new formation (myoma, angioma, etc.). Variation of the emptying time of the stomach at different examinations is of diagnostic importance as it may be due to the presence of a polyp-like massive tumor in the pyloric region which tends to force itself into the pylorus.

The author's cases of submucous myoma and papilloma of the stomach confirm the great diagnostic value of the roentgen examination of this region.

Of decisive importance is the roentgenological demonstration in the stomach shadow of a large, even, rounded filling defect with good mobility and, near it, a soft contour. In cases in which the defect observed after the usual opaque meal exhibits a varying appearance on different occasions (papilloma), an examination should be made after inflation of the stomach with air. When this is done, there is a prospect that the shadow will be rendered distinct. The emptying of the stomach may vary more than in cancer, this being noted in both the routine clinical examination for motility and the roentgen-ray examination. The volume of the stomach usually does not exhibit any restrictions.

Polyposis of the stomach can be diagnosed from the roentgenological demonstration of a constant undulancy over a part of the greater curvature; isolated polyps are shown by persistent defects within this contour.

The very valuable diagnostic features referred to go far to prove the desirability of a careful roentgenological examination, especially in the cases of patients with attacks of melæna for a relatively long time but without any other symptoms of ulcer and the cases of marked anæmia of a secondary type which arises gradually without any demonstrable cause.

In the treatment, resection of the stomach is preferable to mere extirpation of the tumor, as not infrequently it is impossible to exclude malignancy even by inspection of the removed tumor and malignant degeneration of papillomata and myomata seems to be comparatively common.

Clairmont, P.: Extirpation of Carcinoma of the Cardia (Ueber die Exstirpation des Kardiacarcinoms). *Arch. f. klin. Chir.*, 1926, cxl, 343.

Clairmont reports his conclusions with regard to the operative treatment of carcinoma of the cardia. On the basis of his own experience and the reports in the literature he divides the cases into four groups:

Group 1. Cases in which an entirely abdominal operation is possible (laparotomy with extirpation of the cardia and gastric resection followed by end-to-end or end-to-side œsophagogastrostomy with or without the formation of an alimentary fistula). Of four of the author's patients who were treated in this manner, one has remained cured for more than four years. The others died after the operation. Peugniez, Voelker, and Bircher have reported cured cases.

Group 2. Cases requiring a laparomediastinotomy with extirpation of the cardia and gastric resection followed by transdiaphragmatic extrapleural œsophagogastrostomy or œsophagojejunostomy. The author had two cases in this group. Both of the patients died.

Group 3. Cases requiring a laparopleurotomy with extirpation of the cardia and gastric resection followed by transdiaphragmatic, transpleural œsophagogastrostomy or, if anastomosis is impossible, the formation of an external fistula (oral œsophagostomy, gastrostomy) and restoration of continuity with a tube. The author had no case in this group. Zaaijer and Hedblom have reported successful results from this treatment.

Group 4. Cases requiring a laparotomy with exposure of the œsophagus in the cervical region and its intrathoracic (transpleural, retropleural, blunt bimanual) detachment followed by resection of the stomach with total extirpation of the cardia and œsophagus and, if anastomosis is impossible, the formation of an alimentary fistula or collar œsophagogastrostomy. The author had one case in this group. The result was unsuccessful.

Clairmont is convinced that the extirpation of carcinoma of the cardia should be attempted as there have been instances in which the operation has resulted in a cure.

Carcinoma of the cardia is not a rare condition and often occurs between the fortieth and fiftieth years of age. It is frequently a papillary carcinoma with little tendency to penetrate deeply. The patient is affected more by inanition than by the malignancy of the tumor. The tumor has little tendency to advance upward beyond the cardia, but it pushes the usually unchanged œsophageal mucosa upward, thereby leading to an erroneous diagnosis when a specimen is excised for microscopic examination. Unsuccessful results of treatment have been due chiefly to the fact that the diagnosis was made late and the case was inoperable when first seen.

The technique which has been developed only by experimentation on animals must be further perfected. In the author's opinion, the chief essential is an early diagnosis. Because of the untrustworthiness of all clinical methods of diagnosis, including œsophagostomy, the removal of a specimen, and X-ray examination, such symptoms as cardiospasm, beginning dilatation, and atony must be investigated by exploratory laparotomy. Cases in which the general condition is poor and there are extensive and fixed lymph-gland metastases with adhesions to the pancreas or the cœliac trunk, infiltration of the diaphragm, or firm fixation in the œsophageal hiatus are to be regarded as inoperable. Involvement of the spleen renders the prognosis unfavorable but does not definitely contra-indicate operation.

The operation should always be begun with a laparotomy (Kuettner). In cases in which the carcinoma has not advanced upward beyond the cardia and œsophagogastrostomy can be done without difficulty, it should remain an abdominal operation. For other cases the combined methods are to be considered. In Clairmont's opinion the best and safest method of approaching the lower thoracic portion of the œsophagus is extirpation of the twelfth rib and resection of the tenth and eleventh ribs followed by retropleural exposure through the posterior mediastinum forward, passing around the left side of the aorta, as described by Gregoire. The radical operation with restoration of continuity is possible only when the defect is not greater than 8 cm. When the defect is larger, the formation of an external fistula is indicated. The retropleural route is always to be preferred to the transpleural route.

The operation should be performed so far as possible under local anæsthesia. It still remains to be determined whether a several stage operation is preferable to a one-stage procedure, and whether section of the phrenic nerve should be done in the neck or its passage through the diaphragm. The use of jejunostomy as an alimentary fistula is an important aid in the extirpation of a carcinoma of the cardia. VON REDWITZ (Z).

Delore, X., Mallet-Guy, P., and Burlet, J.: Late Results of Resection of the Stomach for Cancer (Étude clinique et prognostic des suites éloignées de la résection gastrique pour cancer). *Presse méd.*, Par., 1926, xxxiv, 1250.

Most statistics on resection of the stomach for cancer emphasize the technique and immediate results. Few of them show that the cases have been followed up clinically for any considerable period of time. The authors report 166 cases in which resection was performed by Delore in the period from 1903 to 1926. Of the 130 patients who recovered from the operation, eighty-eight have been followed up; the rest were operated upon too recently to be included in the study. Of the eighty-eight traced, twenty-two (25 per cent) lived more than three years, but eight of them (9 per cent) died after more than three years. Therefore only 16 per cent made a permanent recovery. Gastrectomy, like other methods, gives a rather low percentage of permanent recoveries, but is generally followed by a period of restored health before recurrence. In the cases reviewed the average duration of this period was eighteen months. The authors find also that the quality and length of the temporary cure are much better after resection than after palliative operations.

It is difficult to establish a period after which recovery can be said to be certain. Three years is quite generally accepted, but one of the authors' patients died of recurrence after six years and another after six years and three months. Of the author's fourteen patients reported as permanently cured, only four are in the rather uncertain period between three and six years. Typical case histories are given of patients in excellent health after more than that period whose lives were beyond doubt saved by the operation. A permanent recovery in as few as 16 per cent of the cases more than justifies the operation.

It is very difficult to make a prognosis as to permanent recovery. Stenosis of the pylorus has been considered as a sign of a favorable prognosis, but the authors' figures do not confirm this theory. The average period before recurrence was eighteen months in patients with stenosis of the pylorus and nineteen months in the others; 69 per cent of the patients with stenosis of the pylorus survived more than a year and 67 per cent of those with normal evacuation of the stomach.

Evidently the prognosis should depend on the extent to which the cancer has become generalized outside the stomach. As the cancer is disseminated by the lymphatic circulation, it might be supposed that enlarged glands would furnish an indication as to the prognosis, but the percentages of survival for more than a year were the same in the patients with enlarged glands as in those whose glands were not enlarged. This is probably explained by the fact that the enlargement of the glands was caused by inflammation and not by invasion of the glands by the tumor.

Colloid cancers were more malignant than the other forms, only 50 per cent of the patients with colloid cancer surviving for more than a year while 86 per cent of those with other forms of cancer survived more than a year. It has been commonly believed that ulcerated cancer is more benign than the non-ulcerated forms but the authors found this true to only a slight extent.

As every ulcer of the stomach is a potential cancer, resection is frequently indicated in cases of ulcer, and the authors believe it is absolutely indicated for old, indurated callous ulcers which are often in the process of degenerating.

AUDREY G. MORGAN, M.D.

Palma, R.: Intestinal Absorption in Ileus from Occlusion (L'assorbimento dell'intestino nell'ileo da strozzamento). *Arch. ital. di chir.*, 1926, xvi, 549.

The importance of intestinal absorption in causing the serious symptoms of occlusion of the intestine has been recognized for a long time but there has been a marked discrepancy in the reports of experimental work. The author carried out investigations on female dogs to determine whether a possible deviation in intestinal absorption in occlusion is due solely to functional changes in the mucous membrane or whether the whole wall of the intestine is involved. He used phenolsulphonephthalein as an indicator, recording the beginning of elimination and the amount excreted in a given time. The observations were made in the first forty-eight hours after occlusion of the intestine and were preceded by control examinations on normal animals.

It was found that up to a maximum of forty-eight hours after the occlusion the capacity for absorption of the central part of the intestine is decreased for some distance from the obstruction. This functional reaction occurs in the peripheral part of the intestine also, but not to so great a degree below the lesion. The disturbance of function increases progressively from the time of the occlusion. The disturbance includes all of the tissues of the wall of the intestine, but the decrease in absorption is due solely to lesions of the wall of the intestine. The duodenum and jejunum show greater sensitiveness than the rest of the small intestine, which is manifested both by the greater reaction of the duodenum and jejunum after constriction of the intestine and the greater degree of change in the intestine as a whole when the occlusion is in the duodenum or jejunum.

AUDREY G. MORGAN, M.D.

Gueullette, R.: Intestinal Invagination: Its Clinical Forms in the Adult. An Experimental and Roentgen Study (De l'invagination intestinale: ses formes cliniques chez l'adulte; étude expérimentale et radiologique). *Presse méd.*, Par., 1926, xxxiv, 1226.

Invagination of the intestine in the adult may be simple, with three cylinders of intestinal wall, and progressive or retrograde (ileal, colocolic, ileocæcal, ileocolic), or it may be complex with five, seven, or more cylinders. It is due to two factors which may act separately or in conjunction—the first, a physiological or anatomical retraction of the intestine on which exaggerated peristalsis acts until it finally pushes a part of the bowel into the next lower segment which is in repose, and the second, traction on the wall of the intestine by a tumor.

When once the invagination has begun, the invaginated segment continues to move forward. Sometimes this forward movement is furthered by abnormal anatomical conditions such as an abnormally long mesocolon, but sooner or later it is arrested by the development of circulatory disturbances and inflammation. These occasionally cause amputation of the invaginated segment, but more frequently strangulate it.

The cause of invagination may be anything that decreases the caliber of the intestine and produces hyperperistalsis; in 40 per cent of the cases in adults the cause is a tumor.

The diagnosis is based on pain, diarrhœa, bloody stools, vomiting, and possibly an abdominal tumor. There are three characteristic roentgen appearances: the "cupola" picture, which shows the vertex of the dome; the "trident" picture, which shows the circular ring at the beginning of the invagination and the lumen of the invaginated part; and a shortening or apparent absence of one segment of the colon.

The disease may be very acute, causing death in a few days, as in the infant, or very chronic, lasting for years with various intervening stages. One special form is retrograde invagination of the jejunum into the stomach after gastro-enterostomy. This is a very serious condition if left to itself. While spontaneous disinvagination or spontaneous elimination of the invaginated segment may occur, this is very rare and cannot be counted on and even with apparent recovery in this way the patient is exposed to serious danger. If the condition is treated in time, the prognosis is not nearly so unfavorable and it becomes very good if the diagnosis is made and treatment given early before signs of toxæmia have developed.

Treatment by external maneuvers and the insufflation of air into the rectum should be abandoned as laparotomy is not associated with any serious danger. The success of surgical treatment depends upon whether or not it is possible to disinvaginate the intestine and on the seriousness and extent of the lesions of the intestinal wall. The general condition must also be taken into consideration. Though resection with immediate restoration of intestinal circulation seems to be the ideal operation, it may be better, in the cases of seriously intoxicated patients, to perform a simpler operation first, such as entero-anastomosis or even simple enterostomy.

The author has collected 102 cases in which disinvagination was done in twenty-seven with recovery in twenty-three (90 per cent); extirpation of the

invaginated part in six, with recovery in four (66 per cent); resection in sixty with recovery in forty-one (66 per cent); anastomosis with or without exclusion in eight with recovery in seven (85 per cent); and section in two stages in three with recovery in two (66 per cent). Therefore of the 104 operations, seventy-seven were followed by recovery. In seven cases in which operation was not performed there were six deaths. AUDREY G. MORGAN, M.D.

Brocq, P., and Gueulette, R.: Intussusception in the Adult; Clinical Types and Roentgenological Study (L'invagination intestinale de l'adulte; formes cliniques et étude radiologique). *J. de chir.*, 1926, xxviii, 369.

Intussusception in the adult may be ileocæcal (the most common form), ileocolic, cæcocolic, simple, double, or double recurrent. Two factors necessary for its occurrence are a diminution in the size of the intestine and a disturbance of normal peristaltic movements. In a few cases, disinvagination occurs spontaneously, but in the majority, strangulation results sooner or later. The strangulated intestine may become detached and thrown off, but this is rare. If the condition is untreated it tends to go on to obstruction, perforation, peritonitis, and death.

Statistics show that 36 per cent of intussusceptions in the adult are associated with tumor, usually a benign tumor of a mobile part of the large bowel. Malignant tumors very rarely cause invagination. Certain inflammatory swellings such as those due to tuberculosis, and other conditions such as Meckel's diverticulum and pericolic membrane account for a small percentage of the cases. The authors doubt if acute or chronic appendicitis causes intussusception very often. Small ulcers of the bowel may be a factor. Leriche found lesions in the plexus of Meissner and Auerbach in a case of intussusception. In 50 per cent of the cases the etiology is obscure.

The symptoms are usually not definite. The authors distinguish a chronic and an acute type. A tumor is felt in about 50 per cent of the cases, and often this tumor is seen to move about from day to day. At times, with an exacerbation of the symptoms, it can be felt to become harder. Dance has described a depression in the right iliac fossa due to the absence of the segment of bowel involved in the invagination. The X-ray may give very valuable evidence, especially in chronic cases. The roentgen picture shows stoppage of the barium along a concave line. The segment of the bowel involved may be invisible or may be traversed by a thin sinuous line of barium.

The treatment is, of course, surgical. The type of operation depends upon the patient's condition and the possibility of disinvaginating the intestine. The authors favor resection and anastomosis when this type of operation is feasible, claiming forty cures in sixty cases treated in this manner.

MICHAEL L. MASON, M.D.

Perrotti, G.: The Plastic Use of Free and Pedunculated Flaps of Omentum in Suture of the Intestine (Evoluzione e meccanismo di azione delle plastiche epiploiche e peducolate in rapporto alle suture intestinali). *Ann. ital. di chir.*, 1926, v, 1012.

The author performed experiments on dogs, using free and pedunculated flaps of omentum to cover incisions of the intestine which had been sutured in two layers. In some of the experiments the intestine was only partially severed, whereas in others it was wholly severed.

He found that the free flaps survived only at the place where they were in direct contact with the intestinal mucosa and could obtain the necessary nutrition from the host tissue. The surviving part participated in the process of healing and contributed to the formation of a solid scar, but the peripheral zone of the flap which was not well nourished degenerated; part of it underwent necrosis and acted like a foreign body, causing a reaction in the adjacent peritoneum which led to the formation of adhesions and a certain degree of constriction of the intestine. Pedunculated flaps of omentum which had abundant nutrition of their own took part as a whole in the process of healing, contributing to the formation of a more solid scar; they did not become adherent to the neighboring peritoneum, or cause any other disturbances. The latter are therefore to be preferred to free flaps.

AUDREY G. MORGAN, M.D.

Rieder, H.: Roentgenological and Cinematographic Observations of Organic Stenosis of the Pars Superior of the Duodenum (Roentgenologische und besonders Roentgenkinematographisches Beobachtungen bei organischer Stenose der Pars superior duodeni). *Acta radiol.*, 1926, vii, 340.

Rieder describes the motor processes in operatively confirmed cases of ulcerous duodenal stenosis. The roentgen examination revealed retention and dilatation of the duodenal bulb and quickly subsiding irregular undulatory movements of the wall of the bulbus. The latter were never transmitted backward toward the stomach. There was no rhythmical peristalsis with wave formation such as occurs in the stomach. The peristalsis of the stomach extended only as far as the pylorus and did not pass over into the bulbus. The individual phases of the bulbus waves varied extraordinarily in their situation, form, and magnitude. The author attempts to explain these wave movements. In addition to the movements described, girdle-like contractions were occasionally noted in the center of the bulbus, i.e., on the border between the pyloric and the distal bulbus tract. These contractions soon relaxed, whereupon there occurred an active movement of the contents of the bulbus and their evacuation in the distal direction.

The motor processes described appeared only after heavy filling of the bulbus and ceased after the completion of duodenal digestion.

Christophe, L., and Hartmann, H.: Duodenojejunostomy for Treitz' Hernia (Duodénojéjunostomie pour hernie de Treitz). *Bull. et mém. Soc. nat. de chir.*, 1926, lii, 1000.

The case is reported of a man 37 years of age who had a tumor in the upper part of the abdomen on the left side which was first noticed six weeks previously when the patient was awakened at night by a severe and continuous abdominal pain. Indigestion, especially for fats, developed five years previously. During the past two years there were alternate periods of diarrhœa and constipation. The slight malaise, the colics, and the occasional vomiting which occurred during constipation ceased when the diarrhœa began. The tumor was the size of an orange, hard, irregular, slightly dull on percussion, painful on pressure, and fixed posteriorly but with some lateral movement. In the roentgen examination the colon filled and emptied regularly with barium; the splenic flexure was found very high and the hepatic angle slightly lowered. Palpation under the screen showed the swelling to be posterior to and independent of the colon.

At operation performed by Hartmann, a lobulated red tumor under the colon was found at the mesenteric border of the first jejunal loop and adhering to the fourth part of the duodenum. Hartmann considered the swelling to be a retroperitoneal glandular mass and closed the abdomen.

After temporary improvement following the operation the symptoms became more frequent and painful. Digestion was slow and difficult and the patient complained of pain in the left hypochondrium which was most intense immediately after meals. The X-ray showed the persistence of a horn-shaped collection of barium in the third part of the duodenum. A second barium meal revealed a gaping pylorus leading into a greatly dilated duodenum. The diameter of the third part of the duodenum was almost that of the stomach. Antiperistaltic waves occurred in the stomach and duodenum. The patient's general condition was very poor. On palpation, the swelling seemed to be semisolid.

At operation, Christophe found a normal liver, numerous adhesions between the gall bladder and duodenum, a small stomach, a large gaping pylorus, numerous adhesions of the small intestines, adhesions of the greater curvature of the stomach to the old operative scar, and numerous intraperitoneal glands. The retroperitoneal tumor was firm and fixed posteriorly. Large glands projected from the surface. Christophe did a duodenojejunostomy. Aspiration of the tumor was negative. Incision into the mass exposed a pocket containing from 50 to 60 c.cm. of bloody fluid and some white cheesy material. A gland and a piece of the wall were removed for biopsy, a drain was placed to the pocket, and the abdomen closed.

The gland showed chronic inflammation and the wall the structure of normal intestine. Chylous drainage was abundant at first but decreased. Digestion was painless and good, the appetite was excellent, and the patient gained 4 lbs., but death resulted from acute œdema of the glottis.

At autopsy the duodenojejunostomy was found well united and patent. The retroperitoneal hernial sac was difficult to locate because of adhesions, but was 15 cm. long and had the diameter of a loop of small intestine. In certain areas its walls were very thick. The communication of this loop with the duodenum and jejunum respectively admitted the point of a fine button scissors. Microscopically the loop showed some infiltration and chronic inflammation.

According to Hartmann, a retroperitoneal hernia in the fossa near the fourth part of the duodenum is rare.

Hartmann reports the case of a man 63 years of age who, for a long time, had suffered from dyspnœa and vague abdominal pain and ultimately intestinal obstruction. At operation the small intestines were found behind a thin serous membrane. The colon and cæcum were flat and pale. From a small orifice near the cæcum a series of distended loops of small intestine could be drawn. The serous covering leaflet was incised until the small intestines appeared to be entirely free. A relatively large transverse vessel was ligated and divided. In exploring from the cæcum along the empty ileum for a short distance Hartmann came upon a red prominence consisting in a loop of small bowel held obstructed by a resistant fibrous fold. This fold was divided. The patient died soon after the operation.

At autopsy, the serous covering membrane, when resutured showed that nearly all of the small intestines were contained in a retroperitoneal pocket. The duodenum had normal relations. From the right lower part of the sac, by a narrow opening, the terminal ileum descended and terminated in a right inguinal hernia. The descending colon was pushed forward. The hernia was prolonged into the pelvic mesocolon to the pelvic fossa. When the hernial sac was emptied of its contents a retroperitoneal pocket of extraordinary size extending below to the pelvic fossa and loosening the leaflets of the pelvic mesocolon was found. The latter was separated into two small compartments by the vessels to the pelvic colon. The sac extended above to the diaphragmatic vault, passing in front of the kidney and behind the spleen. On the left, the sac lifted the descending colon. The fourth portion of the duodenum was on the right.

According to Hartmann, the total number of cases reported to date is 165. Very often the herniæ are found only at autopsy. As a rule operation has been done because of signs of intestinal obstruction.

In the presence of partial intestinal occlusion and tumor there is time for special examinations, as in Christophe's case in which duodenal stasis was found. Christophe considers duodenojejunostomy as the operation of choice in retroduodenal herniæ which detour the food and fix the intestines, thus preventing the jejunum from being drawn further

into the sac. He believes that an operation which relieves simply the incarceration will not prevent recurrence.

According to Hartmann, duodenojejunostomy may be done in chronic cases and those in which, because of adhesions, the hernia is irreducible, but it is not the operation of choice for every retroduodenal hernia. The reduction of the incarcerated intestines with closure of the sac is preferable whenever possible. In the treatment of herniæ on the right side, care is necessary to avoid injuring the superior mesenteric artery which lies on the anterior superior border of the fossa, and in the treatment of herniæ on the left side care is necessary to avoid injury of the inferior mesenteric vein. In complete acute occlusion, relief of the obstruction remains indisputably the operation of choice. Of thirty-seven reported cases, operation was followed by recovery in nineteen (50 per cent).

WALTER C. BURKET, M.D.

Bonnet, P.: Occlusion by Meckel's Diverticulum (Occlusion diverticule de Meckel). *Lyon chir.*, 1926, xxiii, 613.

A man of 29 years entered the hospital with intense abdominal pain and vomiting and absolute retention of stools and gas. Examination showed distention of the abdomen and absence of peristalsis. The most severe pain was felt a little below the umbilicus. Examination revealed also a small, reducible umbilical hernia which was very sensitive on palpation. Appendicitis was excluded by absence of pain in the right iliac fossa and the low temperature and pulse rate. The patient's father had died of tuberculosis and the patient had had attacks of abdominal pain since childhood. These facts suggested the possibility of occlusion by a band or an adhesion due to an old tuberculous peritonitis. Rectal palpation combined with hypogastric palpation gave the impression of distended loops of small intestine and elicited a splashing sound. The condition was believed to be a localized occlusion of the small intestine, probably by a band.

Operation showed some of the loops of small intestine strangulated under a red cord resembling an intestine without a mesentery. The latter proved to be a Meckel's diverticulum 15 cm. long which was firmly adherent in the retromesenteric fossa to the posterior abdominal wall. The cord was cut between two ligatures with the thermocautery. Near its parietal insertion it had no lumen. The diverticulum was resected at its insertion into the intestine and the wound drained. Uneventful recovery followed.

Two points of interest in this case were the strangulation of the small intestine by a fixed diverticulum which, with the mesenteric cord stretched behind it, formed an unyielding band, and the existence of the malformation in the umbilical region, which the author thinks is an important diagnostic sign in such a case.

AUDREY G. MORGAN, M.D.

Lavesson, H.: Studies on So-Called Ileocæcal Invagination (Studien ueber die sogenannte Invaginatio ileocaecalis). *Acta chirug. Scand.*, 1926, lxi, 48.

The author describes the following forms of intussusception occurring in the ileocæcal region:

1. Cæcal invagination—invagination of the cæcum only, a cæcocæcal invagination, or ot the cæcum into the colon, a cæcocolic invagination, the ileum remaining in its usual place.

2. Cæco-ileocolic invagination, a further development of the cæcal invagination, the ileum being drawn up into the colon.

3. Ileocolic invagination, an invagination of the ileum into the colon with the cæcum remaining in its place.

4. An ileocæcocolic invagination, a further development of 3, in which the cæcum is drawn up into the colon.

Of these various forms, the cæco-ileocolic invagination is by far the most common. Of twenty-four cases of intussusception observed at the Trelleborg Municipal Hospital eighteen were of this type. The purely cæcal type occurred in five cases, whereas only one case of the ileocæcocolic variety was observed. There was no case of ileocolic intussusception.

From his own observations the author concludes that the most common cause of the invagination is œdematous inflammatory changes in the mucous membrane. The frequency of such changes in the cæcum is due to the structure and shape of this portion of the intestine and its greater bacterial content as compared with the ileum. The inflammatory œdema varies considerably, sometimes leading to such marked swelling of the intestinal wall as to simulate a tumor. In other cases the changes are less pronounced, being confined to one or several haustra.

The author deals with the symptoms in the different forms of intussusception and the possibilities of establishing the diagnosis.

Although admitting that excellent results may be obtained by non-operative treatment, he is of the opinion that with the present improved surgical technique, the condition should be treated surgically. In the twenty-four cases reviewed, all of which were operated upon, a premanent cure was obtained.

Hurst, A. F.: The Diagnosis and Treatment of Colitis. *Lancet*, 1926, ccxi, 1151.

No diagnosis is made with greater frequency and with less justification than that of colitis. The diagnosis of colitis should never be made until a thorough investigation has shown that inflammation of the colon alone is present.

The presence of mucus is not indicative of colitis. Repeated sigmoidoscopic examination of patients passing large amounts of mucus have failed to show the slightest sign of inflammation. In true colitis the mucus always contains pus cells. The presence of visible blood indicates ulcerations.

There can be no doubt that colitis is almost always due to infection, but it is rarely possible to tell in a given case what organism is responsible for the disease.

It is no more justifiable to treat colitis without a sigmoidal examination than to treat tonsillitis without looking into the throat. The sigmoidoscope can be passed easily with the patient in the knee-elbow position. If the mucous membrane of the rectum and pelvic colon is healthy, ulcerative colitis can be excluded immediately as the disease starts and persists in the distal segment of the colon. When a patient passing blood and pus in the stools shows no evidence of ulcerative colitis on sigmoidoscopic examination a growth of the colon is almost certain to be present. If the growth is within 12 in. of the anus it should be recognized though it cannot be palpated.

Roentgenological evidence of colitis is variable and a diagnosis made from the X-ray plate without other confirmation is unreliable. An X-ray examination should always be made in long-standing cases which are not responding to treatment. It may reveal diverticulitis, ulceration, or stricture.

Strictures and polypi are occasional complications, but following improved methods of treatment complete healing results in the majority of cases.

In the treatment of colitis the patient should be kept in bed until the sigmoidoscope shows complete recovery. A generous mixed diet from which all solid residue has been removed should be given. Fresh air and sunlight help to improve the general condition.

A polyvalent antidysenteria serum is often very beneficial.

Local treatments are of value. The author usually employs tannic acid, from 1 to 2 gr. to the oz. There is no evidence that so-called intestinal antiseptics exert any influence. Saline aperients or paraffin should be used to keep the stools soft.

Surgery is indicated only in dealing with the complications, but in extremely refractory cases appendicostomy may be done.

WILLIAM E. SHACKLETON, M.D.

Nordmann: The Development of Surgery of the Colon in the Last Twenty-Five Years (Entwicklung der Dickdarmchirurgie in den letzten 25 Jahren). *50 Tag. d. deutsch. Ges. f. Chir.*, Berlin, 1926.

The diagnosis of colonic ailments has been advanced by the X-ray. X-ray examination has shown, as was previously determined clinically, that besides the normal peristalsis there is an antiperistalsis, and that the colonic contents do not pass through newly created anastomoses, but are carried along the old route by physiological peristalsis. Anastomosis is therefore practical only in the presence of an impassable stenosis. Surgical treatment of dynamic obstipation is of little avail. Finsterer has reported good results in obstinate obstipation from resection of the descending colon, but in Nordmann's opinion this is too dangerous. Payr also warns against surgical interference as long as there is no certain differentiation between dynamic and mechanical forms of obstipation.

Congenital abnormalities of the colon include total and partial atresia, congenital stenoses, and malformations due to arrest of development. In such conditions the operative procedure should be as simple as possible, viz., the formation of an intestinal fistula central to the atresia or stenosis.

Abnormal dilatation and marked motility of the cæcum do not require surgical interference. They occur so frequently that they cannot be regarded as pathological. Torsion of the cæcum, however, should be operated upon as soon as possible. If the bowel is still viable, it is sufficient to untwist it and fix it in the normal position. In gangrene of the cæcum, the cæcum and ascending colon should be resected.

Jackson's membrane, the ligamenta variformia, and double splenic flexure are due to developmental disturbances in embryonic life. They require surgical interference only when the X-ray shows that they are causing obstruction or interfere with colonic movements. These complications, however, seem to be very rare. Nordmann warns against operative procedures on these membranes, especially resection of the ascending colon, when the symptoms are vague.

Megacolon, a congenital condition, first causes definite disturbances when there is kinking and obstruction at the root of the efferent loop. Associated enlargement of the urinary bladder is also the result of a disturbance of embryonic development. The surgical treatment of megacolon depends upon the patient's general condition and age and the anatomical findings. In all cases the enlarged colon must first be emptied. If enemas are not sufficient, a cæcostomy is necessary. The latter is preferable to the formation of an artificial anus in the megacolon. In uncomplicated cases in which the general condition is good, the one-stage resection is the method of choice provided the large loops have been successfully emptied. In the cases of small children with extensive filling of the megacolon, the cases of weak and sick patients, and cases with volvulus at the flexure the several-stage resection is preferable.

Diverticulitis of the colon is more common than has been thought. It occurs more frequently in obese than thin persons and causes pain similar to that of appendicitis on the left side. The rupture of a diverticulum into the bladder is not rare. In such cases the differentiation of the condition from carcinoma is difficult even with the aid of the X-ray. In uncomplicated cases a one-stage resection is indicated, but in complicated cases, especially those with rupture into the bladder, the formation of an artificial anus is necessary. The unfavorable prognosis can be improved only by early diagnosis.

Isolated ulcers of the colon are very rare. They occur most frequently in the ascending colon. They are usually first diagnosed when they perforate.

Ulcer of the colon may produce a phlegmon of the colonic wall. The best treatment in such cases is a one-stage resection when the phlegmon is situated on the right side and a multiple-stage resection when the phlegmon is situated on the left side. The prognosis of these cases is very unfavorable. In forty cases there were numerous deaths, but a few lives were saved by ileocolic resection. When, in the performance of an appendectomy, the findings are too slight to account for the complaint, it is advisable to examine the colonic wall for phlegmon.

The postoperative neurotrophic colitis associated with profuse diarrhœa which occurs most frequently after gastro-enterostomy is due usually to a disturbance of the acid secretion in the stomach and requires the oral administration of hydrochloric acid.

In acute colitis, surgery is indicated only when there is paralysis of the bowel due to toxic action on the ganglia or there is uncontrollable hæmorrhage.

In chronic colitis, whether due to a specific ailment or a bacterial cause, operation is indicated if dietetic measures are of no avail. The type of operative interference depends upon the extent and severity of the ailment. Appendicostomy is of value only in mild cases. A more effective procedure consists in making a Witzel fistula in the cæcum and irrigating through a tube. If the rectum is involved, as in 70 per cent of the cases, it may be advisable to make an artificial anus and thereby deal directly with the separated portion of bowel. If the rectum is uninvolved or has been cured and the colon is not benefited by the irrigations it may be necessary, in very severe cases, to implant the lowest loop of ileum into the flexure and remove the entire colon. If the diet is properly regulated after this procedure the bowel movements will be normal and there will be no diarrhœa.

The appendices epiploicæ may become affected either mechanically through pressure or torsion or by infection occurring embolically or by direct extension from the infected colon. The treatment consists in resection of the affected appendages and invagination or infolding of the colon at the affected point.

Inflammatory tumors of the colon may be either specific or non-specific in origin. Appendicitis may cause pseudo-tumors in the region of the cæcum. The differentiation of such growths from malignant tumors may be impossible. In such cases the treatment should be that of a malignant tumor. Benign tumors such as lipoma and harmless polyps usually cause symptoms first when they bring about invagination. Carcinoma must be thought of in all cases of constipation or diarrhœa, even before the occurrence of hæmorrhage. Roentgen examination should be done as early as possible. Although today from 32 to 59 per cent of the cases are first seen by the surgeon in the inoperable stage, the stage of ileus, X-ray investigation has increased the incidence of early diagnosis. Carcinoma cannot be ruled out merely on the basis of a negative examination of the stools for blood.

In carcinoma of the colon the results of surgery are good because the condition may remain stationary for a long time and rarely leads to glandular metastases. The author cites statistics from Koerte's practice. Fifty per cent of the cases were operable. Up to 1913, 207 cases were operated upon with a mortality of 42 per cent. Later, 360 cases were operated upon with a mortality of 27.8 per cent. In the past ten years the mortality has been only 19.3 per cent. There were 141 cases of carcinoma of the colon on the right side with a mortality of 26 per cent, and 136 cases of carcinoma on the left side with a mortality of 30 per cent. The mortality in cases treated by several-stage resection was 28.4 per cent, while that in cases treated by one-stage resection was 28 per cent. In the presence of ileus, the mortality of one-stage resection was 70 per cent and that of several-stage operation from 40 to 50 per cent. In cases treated by entero-anastomosis the mortality was 60 per cent. According to the earlier statistics, 40 per cent of the patients survived for three years; later the number was increased to from 50 to 64 per cent. The length of life after palliative treatment ranged from two to seven years. On the basis of these statistics, the author reaches the following conclusions:

1. In uncomplicated cases, one-stage resection is the method of choice.

2. In carcinoma of the cæcum, ascending colon, and hepatic flexure, the entire ascending colon should be removed and an anastomosis, either end-to-end or end-to-side should be made between the lowest loop of the ileum and the transverse colon. In end-to-side anastomosis, the blind pouch must be made as small as possible.

3. In carcinoma of the splenic flexure, an extensive resection of the colon, especially the descending colon, must be done and followed by end-to-end anastomosis.

4. In complicated cases with ileus and the cases of very sick persons, a cæcostomy or the formation of an artificial anus must be done first. In cases of operable tumor, primary resection in a second stage, and the closure of the fistula or artificial anus in a third stage are indicated.

5. The two-stage resection is preferable to the one-stage operation only rarely and then only when the left side is affected and the patient is very obese.

6. Because of the danger of infection, an artificial anus capable of being closed by a plastic procedure should never be done primarily. If the patient is given a suitable diet and wears a pad, he will be able to return to his work. If, in a benign condition, the artificial anus is to be permanent, a second-stage operation according to the method of Brewitt or Hirschmann may sometimes be possible.

With regard to the technique of operation Nordmann states that if the appendices epiploicæ interfere with the circular anastomosis of the colon after

resection, they should be resected before the suturing is begun. It is best to make a double row of interrupted sutures and protect the suture line with omentum.

The end-to-end anastomosis is preferable to lateral union because of the danger in the latter of a blind sac. Drainage and tamponade is dangerous and superfluous.

In the two-stage resection the spur should be as short as possible. The procedure of Payr is usually best.

In the formation of an artificial anus it is desirable to pull the colon through the separated fibers of the rectus muscle as this gives some degree of control over the artificial anus. In the closure of an artificial anus or a fæcal fistula the surgeon should not hesitate to open the abdominal cavity as this will allow a more careful suture of the bowel. The old skin plastics should be abandoned.

In the discussion of this paper, BRUENING (Lichterfelde) reported two cases of megacolon. The first was that of a newborn infant with what was at first believed to be atresia. The true nature of the condition was revealed by the X-ray. Digestion was improved by daily enemas. The second case was that of an 8-year-old boy with marked dilatation of the entire colon. Because of increasing pain, a total resection of the entire colon was done with lateral anastomosis between the lowest part of the ileum and the rectum. The operation was well tolerated, but the patient died four weeks later of a phlegmon of the floor of the mouth which probably had some relation to it. Both cases demonstrated the congenital nature of the condition and supported Bruening's hypothesis that the cause of the giant growth of the colon is trophic dysfunction consequent upon an abnormal anlage of the segmental vegetative centers in the spinal cord.

Besides this congenital megacolon with dilatation of the entire colon including the cæcum and appendix, there is an acquired megasigmoid which is brought about by mechanical hindrances such as valve formation, kinks, abnormal loop formation, shrinkage of the mesocolon, scar tissue, and spastic conditions, and is usually limited to the sigmoid, only occasionally involving the descending colon. Whereas this condition may be cured by a partial operation, true Hirschsprung's disease requires total resection.

STEINTHAL (Stuttgart) discussed the pathogenesis and operative treatment of megacolon. He agrees with Nordmann on the subject. He reported the case of a 30-year-old patient who, since childhood, had had an enlargement of the colon extending from the sigmoid to the ascending colon and to the rectum. On account of the increasing pain, a several stage resection was done. Because of the extent of the condition, this case refutes the neurogenic theory of Bruening. Moreover, since after the formation of the artificial anus the irrigation fluid passed not only from the rectum to the artificial anus but also in the opposite direction, it refutes also the mechanical theory favored by Koenig and the view of Perthes that there is a valve formation at the root of the sigmoid flexure. X-ray examination made after the administration of bismuth by mouth showed, at the transition of the distal loop of the sigmoid flexure into the rectum, a kink which was not seen in the first examination with the barium enema. Steinthal attributed the kink to the sinking of the heavy flexure into the small pelvis. He believes this to have been a case of congenital megacolon causing increasing difficulty with the lapse of time.

KLEINSCHMIDT (Leipzig) discussed the etiology of megacolon. He called attention to the fact that there are three nerve tracts to the lower portion of the colon: (1) the autonomic system, which is located in the intestinal wall, (2) the vegetative (sympathetic and parasympathetic) system, and (3) the spinal nerve system. He described briefly the complicated act of defæcation. In the dog, there is a special nerve, the nervus pelvinus, which supplies the lower part of the large intestine. Section of this nerve is followed by dilatation and obstipation of the loops it supplies; this is demonstrable with the X-ray. In man, the nerve corresponding to the nervus pelvinus is the ramus colicus of the sacral nerve. In one case of Hirschsprung's disease, Kleinschmidt was able to demonstrate deficiency of this branch.

BUDDE (Cologne) stated that in his opinion stenoses of the intestinal tract are usually due to strangulation and volvulus during embryonic development. In most cases the intestine is able to untwist itself spontaneously, but in others it is not. Budde reported a case in which the entire first part of the colon was involved, the occlusion extending up to the flexure. The cæcum was found high under the liver. The colon was twisted on its long axis. Budde agrees with Nordmann that the treatment of these atresias and stenoses should be as conservative as possible. As the condition is often fatal after the formation of a fistula, an attempt should be made to effect an anastomosis. Budde reported two cases.

KEYSSER (Lichterfelde) discussed the one-stage resection. He claimed that the chief dangers are the suturing of the colon to the colon and the frequently unavoidable tension. He has therefore attempted to unite the colon with the small intestine with a lateral anastomosis which, because of the dangers of the multiple-stage operation, he does in a one-stage. Keysser has resected in this manner (ileo-colonic resection) tumors of the splenic flexure and the upper part of the descending colon as well as those of the ascending colon. When the omentum is invaded it is resected with the tumor. The operations were done for the most part under local anæsthesia (infiltration of the cœliac ganglion and the mesocolon). In two cases of ileus due to carcinoma he performed the operation in one stage. In cases with stasis in the small intestine or a beginning peritonitis, an artificial anus must be made. In eight cases operated upon in this way there was

only one death, that of a patient who died of pneumonia on the sixth day after the operation. There were no disturbances of the intestinal tract. Extensive resection is followed by diarrhœa, but this ceases after three or four months.

MELZNER (Koenigsberg) discussed end-to-end versus lateral anastomosis of the bowel. In experiments on animals, the function of the two types of anastomosis was observed in the open abdominal cavity after stimulation of the peristalsis by the local application of 10 per cent barium chloride solution. In the lateral anastomosis the ring-shaped wave of contraction was absent from the entire area of anastomosis, whereas in the end-to-end anastomosis the peristalsis was completely normal clear up to the point of union. Melzner attributes the difference to the fact that in the lateral anastomosis the circular fibers are severed and thus are thrown out of function, whereas in the end-to-end anastomosis they remain intact. On the same grounds end-to-end anastomosis if preferable to side-to-side anastomosis.

HARTERT (Neustrelitz) stated that for the treatment of volvulus of the sigmoid flexure, colopexy is no longer in favor since, in spite of very careful fixation, recurrence develops relatively frequently and on re-operation it is found that the fixation is entirely loosened or the adhesions between the loop and the abdominal wall have been drawn out, giving the loop sufficient mobility for retwisting. Since the other conservative methods may also be followed by recurrence, resection is becoming more and more the procedure of choice for all cases of volvulus. Hartert believes that this is going too far. The danger of primary resection of the colon is out of proportion to the simplicity of the conditions in uncomplicated volvulus. Detorsion avoids every immediate danger, and in a large percentage of cases results in an apparently permanent cure. The harmless colopexy will come more into favor in such cases when its certainty will have been increased. Its results are greatly improved by fixation of the loop with living tissue analogous to the procedure of Perthes in which the ligamentum teres of the liver is employed to support a ptosed stomach. In one of his cases, Hartert used the following procedure:

Detorsion was done through a midline incision. The loop was then emptied of gas by puncture, and fluid was removed by massaging it out through the anus through an intestinal tube. Then, through another incision in the left flank, the sigmoid was pulled out into the correct position with control from the midline incision. A broad strip of aponeurosis was then cut from the outer edge of the external oblique muscle, but left attached to the muscle by a pedicle. This strip of aponeurosis was pulled through the upper part of the mesosigmoid. The loop was then brought back and the strip of aponeurosis fixed to the abdominal wall.

Three months after the operation the loop was still in position.

Colopexy is contra-indicated in cases with gangrene and in protracted cases with overloading of the rest of the bowel.

FISCHER discussed the results of the surgical treatment of colitis. The etiology of this condition is variable. Fischer is opposed to irrigation methods and the Witzel fistula. In this condition there are anatomical borders formed by epithelial regeneration and the formation of scars which interfere with function. Fischer studied these borders in animals. Scars in the submucosa make of the bowel a dead tube. In the presence of confluent ulcers larger than a mark, the surgeon should not hesitate to perform a resection, but this stage should be prevented by early care. Fischer does not agree with Nordmann that acute colitis should never be treated by the formation of a fistula. He believes, with Hochenegg, that such treatment is warranted in severe cases. With regard to cancer, Fischer stated that he does not depend entirely on the X-ray for the diagnosis as roentgen examination gives four times as many negative as positive results. With regard to the innervation of the lower colon described by Kleinschmidt, he stated that after resection of the rectum, defæcation often ceases and fæces remain in the colon. This may well be explained by an injury to the ramus colicus.

KAUSCH (Berlin) reported that he prefers lateral anastomisis with the smallest possible blind sac. In complicated cases he draws the bowel out at the site of the volvulus or megacolon. In his opinion it is not necessary to resect the entire colon in megacolon.

FINSTERER (Vienna) agrees with Nordmann that colon resection is not without danger, but he believes also that entero-anastomosis is no less dangerous. The chief essential is evacuation of the bowel to remove the toxins before operation. If this is successful, resection may be performed even on old persons. Finsterer favors a very broad (10 cm.) lateral anastomosis. The blind sac should be as small as possible.

BREWITT (Luebeck) discussed methods for the closure of an artificial anus. The newer methods depend upon the formation of a Sauerbruch canal through which closure is effected by the introduction of an instrument. The pressure produced in such methods may result in an intestinal fistula. In the method used by Brewitt the attempt is made to prevent this complication. The transverse colon is pulled out through an incision under the rib margin and covered by a skin flap. This portion of bowel covered with skin is then held closed by pressing it up against the rib margin by a pad. The pad is removed for one hour every day to permit bowel movements. Healing occurs in ten days, during which time opium is administered to place the bowel at rest.

VON BECK (Karlsruhe) has attempted complete colon resection in fifty-four cases. He found that in some cases lateral anastomosis was followed by pain due to antiperistalsis, whereas end-to-end anasto-

mosis had no painful sequelæ. In resection he has not sutured up the blind end but has brought it out externally. In ten cases of ulcerative colitis he performed extensive resections, in some instances in three stages. There were only two deaths. In many of the cases the condition developed during an epidemic of dysentery.

ANSCHUETZ (Kiel) stated that in his opinion too much resection is being done in megacolon. The primary dilatation usually occurs in the sigmoid, the dilatation of the rest of the colon being secondary. Consequently it is sufficient to resect only the sigmoid. This he did in the cases of seven children under 5 years of age. In volvulus he has tried exteriorization with variable results. These cases must be individualized, operation sometimes being performed in one stage and sometimes in several stages. In general, primary resection is best, but in difficult cases fixation is justified. Anschuetz has seen very difficult cases of chronic colitis following dysentery. He is accustomed to making a very high lying anus. He often performs an exploratory operation to determine the condition of the bowel. He recalls tumor-like formations which were due to tricocephalus. In acute colitis he has saved a few lives by operation, but has also lost many cases.

KOERTE reported a case of chronic colitis in which he established his enteric fistula. The patient now feels so well that he will not permit closure of the fistula.

ORTH (Hamburg) emphasized the importance of the X-ray in revealing the extent of intestinal tuberculosis and as an aid in the diagnosis of ulcerative colitis. He warned that in intestinal tuberculosis ileosigmoidostomy may be followed by a fatal diarrhœa.

PERTHES (Tuebingen) stated that he has operated on only three cases of megacolon since 1914. All of the operations were one-stage resections and resulted in a cure. In one case of severe habitual obstipation he removed the left half of the colon, including a large part of the flexure. He considers it essential to leave part of the colon. Of late, he has been using copious irrigations of water to empty the bowel.

PENDL (Troppau) reported that he is in favor of giving castor oil the day after a colon operation. He has performed colon resection in forty-two cases with only two deaths. One death was due to the performance of the operation in the absence of the proper indications, and the other to the removal of a myoma at the time of the colon resection.

REICHEL (Chemnitz) stated that, in the absence of complications and fæcal stasis, colonic tumors may be removed in one stage, but such favorable conditions are not found frequently. The chief danger lies in failure of the sutures due to the impaction of fæces. A one-stage operation is usually possible on the right side because in the right colon the fæces are more fluid. Of twenty-five resections for carcinoma of the sigmoid flexure, Reichel was able to do only six in one stage. His total mortality for colectomy is 22 per cent. In his cases of carcinoma of the flexure the mortality of several-stage resection was 15.8 per cent.

PAYR (Leipzig) recommended for cleansing of the bowel for X-ray work, pre-operative and post-operative care of the colon, and the treatment of chronic obstipation, the irrigating apparatus which has been used by him with very good results since 1911. For cases of obstruction due to mechanical causes operative interference is necessary for permanent results. Payr reported a case of gradually increasing stenosis at the flexure with menstruation through the rectum. The occurrence of an injury during a dilatation of the cervix performed some time previously was improbable. The X-ray showed marked adhesions and torsion of the sigmoid flexure above the rectum. Operation revealed in addition, a broad band-like adhesion between the fundus of the uterus and the sigmoid, fresh inflammatory adhesions, and a tumor in the bowel wall. Payr established an artificial anus, with the intention of performing a resection later. He asked if similar cases of menstruation through the rectum were known. The studies of Schmieden suggested the possibility in this case of a hidden papilloma, since on one occasion a necrotic piece of tissue with a glandular structure was expelled.

VON HOFFMEISTER (Stuttgart) described a common type of case which begins with a sudden passage of fæces followed by obstipation and in which the X-ray shows stagnation but no stenosis and the bowel movements are interfered with by a membrane formation. The treatment in such a case is division of the membrane or the establishment of an anastomosis between the jejunum and the transverse colon.

HUEBENER reported a case of injury of the colon in which a piece of tissue 15 cm. long containing mucosa and submucosa was removed. An artificial anus was then formed and later was closed. A cure resulted.

In conclusion, Nordmann stated that operation is rarely indicated in acute colitis. In contrast to Finsterer, he believes that resection is a more formidable procedure than anastomosis. He would hesitate to give castor oil immediately after the operation as recommeneded by Pendl. He believes that the condition in Payr's case was a sigmoiditis and that a perforation occurring in the dilatation of the cervix was the cause. He emphasized the importance of receiving cases in the uncomplicated stage when a one-stage operation is possible.

STETTINER (Z).

Livingston, E. M.: The Skin Triangle of Appendicitis: A Discussion of Its Significance and Its Diagnostic Value as Observed in More than 400 Cases of Acute Appendicitis. *Arch. Surg.*, 1926, xiii, 630.

The most reliable single diagnostic sign of acute appendicitis is cutaneous hyperæsthesia in the skin triangle. This was noted in 86 per cent of 428

consecutive cases seen during a period of six and one-half years at Bellevue Hospital, New York. The observations were recorded by more than sixty surgeons, internes, and student clerks. The recognized classical signs appeared with the following frequency: leucocytosis in 76 per cent; typical pain in 75 per cent; nausea and vomiting in 70 per cent; fever in 67 per cent; and localized rigidity in 59 per cent.

The skin triangle is bounded by a line drawn from the umbilicus to the high point of the crest of the ilium and extending thence to the right pubic spine and up to the umbilicus. The test described is as follows:

The skin is picked up between the thumb and index finger and pulled quite forcibly away from the abdomen. For the initial pull a non-involved area such as the left lower quadrant is selected. When the patient signifies discomfort, the degree of traction at that moment is used as a standard of intensity since persons vary in their susceptibility to discomfort. As nearly as possible, identical traction is used on all quadrants of the abdomen. In this way the hyperæsthetic area characteristic of the acutely inflamed appendix is mapped out.

The area is always limited by the triangular border, and the hyperæsthesia is of maximum intensity in the middle of the triangle.

In all cases in which the skin sign was negative, a perforative or gangrenous appendicitis was found. The localized hyperæsthesia is both an early and a late sign. CHARLES F. DUBOIS, M.D.

Colp, R.: External Fæcal Fistulæ in Acute Appendicitis. *Ann. Surg.*, 1926, lxxxiv, 837.

Of 2,841 consecutive cases of acute appendicitis, 1.1 per cent developed a fæcal fistula. The formation of a fæcal fistula occurs most frequently in acute gangrenous appendicitis with perforation and abscess. It is favored by rough manipulation and improper or poorly placed drainage. The best drain is composed of soft, pliable, pure gum black rubber tubing.

The author believes that the "simple drop" method, in which the ligated stump of the appendix is dropped back into the free peritoneal cavity after thorough carbolization tends to lower the incidence of fæcal fistula.

When fæcal fistulæ are once established, drainage tubes should be shortened or removed. If this is not feasible, tubes of softer and smaller caliber should be substituted.

The majority of fæcal fistulæ occur within the first week. The fistulæ which make their appearance early take longer to heal than those which develop later. Provided there is no mechanical factor or obstruction distal to the intestinal opening, the majority of fæcal fistulæ of appendiceal origin will heal spontaneously if treated conservatively. In this series, only 12 per cent of the patients were subjected to surgical interference.

HERMAN H. HUBER, M.D.

Richard, A.: Operative Treatment of Carcinoma of the Transverse Colon Exclusive of the Flexures (Traitement opératoire des cancers du colon transverse, angles non compris). *J. de chir.*, 1926, xxviii, 513.

Richard reviews the anatomical factors governing the surgery of the transverse colon. In 139 cases a cure was obtained in 63.4 per cent and 20.9 per cent of the cured patients remained well for three years.

The three most logical and successful procedures are: (1) segmental resection following the formation of a cæcal anus, (2) fixation of the affected loop of bowel outside the abdomen and its later resection with the peritoneal cavity closed, and (3) right hemicolectomy when the right, relatively mobile part of the transverse colon is affected.

On the cadaver, Richard has worked out a technique which permits the removal of the retropancreatic lymph glands draining the left two-fifths of the transverse colon. He believes that the glands along the greater curvature of the stomach should be removed at the time the colon is resected. If the two ends of the colon to be sutured are disproportionate, exclusion of the bowel by means of a cæcostomy will result in the return of the colon to its normal size and permit an anastomosis. If occlusion is present, an exclusion should be performed and excision should be done only if great improvement results. Adhesions to neighboring organs constitute a contra-indication to radical operative procedures.

The article gives the details of most of the operative procedures and reviews the 139 collected cases. It is supplemented by an extensive bibliography. MICHAEL L. MASON, M.D.

Miller, N. F.: Atresia Ani Vaginalis, Its Correction: with the Report of a Case. *Surg., Gynec. & Obst.*, 1926, xliii, 785.

Atresia ani vaginalis is defined by Miller as a type of anal deformity in which the normal anus is absent and the rectum, instead of opening through the anus, terminates directly or through a fistulous tract in some portion of the vagina. The opening is generally low, the vaginal fourchette being a common location. The higher the opening the more severe the symptoms and the more difficult the treatment.

The condition is due to a developmental defect. Under normal conditions, the cloaca, which functions as an outlet for the intestinal and urinary tracts, becomes partitioned at the time of union of the hind-gut and anal indentation. The partition later becomes the rectovaginal septum. Atresia ani vaginalis results from incomplete division of the cloaca and non-union of the rectum and anus. Among the factors suggested as responsible for this lack of development are a poor blood supply, adhesions, and inflammation.

The symptoms vary with the size and location of the opening and the presence or absence of sphincteric fibers around it. When the opening is large and control is rendered possible by the presence of

sphincteric fibers in the surrounding tissues, there may be no symptoms at any age. When the opening is small, symptoms consisting chiefly in constipation, colic, vomiting, tympanites, and sometimes obstruction, appear early. In old cases there may be enormous distention of the large bowel and rectum. While the physical suffering is of chief importance, the mental anguish in these cases is also considerable.

For immediate treatment in the newborn infant the author recommends simple dilatation with no further measures until the age of puberty. Operation thereafter offers much in the way of relief.

After discussing the various operative procedures heretofore used, the author reports a case and describes the method used by him in the correction of the defect in this instance. An incision through the skin and superficial tissue was made from the fourchette to the tip of the coccyx and a circular incision outside the rectovaginal opening. Then, after dissection of the posterior vaginal wall, the entire fistulous tract connecting the vagina and rectum was freed, a passage was made with a hæmostat from the normal anal site to the juncture of the fistulous tract and the rectum, and the vaginal opening of the tract then carried down through this muscular tunnel to the site of a normal anus, where the new opening was fixed to the skin edges. All defects were then closed and the raw edges approximated as in perineorrhaphy.

The procedure described seems to offer a simple means of correcting atresia ani vaginalis for the following reasons:

1. The avoidance of extensive cutting tends to lessen scar tissue formation and contraction with narrowing of the anal canal.

2. The use of the fistulous tract for the anal outlet renders the procedure simple and practical.

3. The utilization of the apparently normal sphincter results in entirely satisfactory control.

4. The development of normal sphincteric support materially lessens the chance of rectal prolapse.

JACOB M. MORA, M.D.

LIVER, GALL BLADDER, PANCREAS AND SPLEEN

Hall, W. W.: Useful Hepatic Function Tests. *U. S. Naval M. Bull.*, 1926, xxiv, 843.

The liver has a number of different and unrelated physiological functions. It stores carbohydrates as glycogen, helps to maintain the blood-sugar level, excretes bile pigment, cholesterol, and bile salts, constitutes the important site of intermediary nitrogen metabolism, detoxifies toxic substances, helps to remove particulate matter and bacteria from the blood, aids in the coagulation of the blood by the production of fibrinogen, and excretes a number of foreign compounds, such as the dyes, in the bile.

No one single test is sufficient for all of these functions. The three determinations which possess the greatest simplicity, accuracy, and clinical value are: the icterus index, the van den Bergh test, and the bromsulphalein hepatic function test.

The icterus index test is a simple colorimetric method of determining the icteric tint of the serum. The technique is described in detail. The normal range is from 4 to 6. In latent jaundice the index ranges from 7 to 16 and in clinical jaundice from 17 upward.

The van den Bergh test gives a quantitative estimation of bilirubin in the serum and differentiates bilirubin of hæmolytic origin from that of obstructive origin. The reaction depends upon the development of azobilirubin, a red azo dye. The two types of jaundice are differentiated by the fact that in obstructive jaundice the bilirubin combines directly with the diazo reagent to form azobilirubin, while in hæmolytic jaundice it is bound in such a way that it requires the addition of alcohol to the serum for the formation of azobilirubin. The two forms of jaundice represent pathological lesions of a distinctly different location and type.

The theory of bilirubin formation and excretion is reviewed and the technique of qualitative and quantitative determinations is described in detail. In the author's hands, a modification of the original van den Bergh technique for the preparation of the cobalt sulphate standard has given the best results. The interpretation of the immediate or prompt reaction, the delayed reaction, and the negative reaction is outlined.

The bromsulphalein hepatic function test is chosen because it offers a simple and accurate method of liver function as measured by the excretion of that class of substances. Hall believes that bromsulphalein (phenoltetrabromphthalein sodium sulphonate) may be given without the least fear of an untoward reaction. The technique is outlined. A calculated amount of the dye is injected intravenously and thirty minutes later a specimen is recovered from the vein of the opposite arm. An estimation of the amount of dye present is made by direct comparison with a series of standards. Under normal conditions, approximately 35 per cent of the dye is present in the serum after five minutes, and at the end of thirty minutes the dye is entirely gone. The amount remaining in the serum at the end of thirty minutes is taken as the measure of lost hepatic function. The amount excreted in the urine bears no relation to the test from a practical standpoint.

Several case reports and a bibliography are given.

DON K. HUTCHENS, M.D.

Friedenwald, J., and Armstrong, W. W.: Bromsulphalein Test in the Clinical Study of Liver Functions. *Med. J. & Rec.*, 1926, cxxiv, 679.

The functions of the liver are numerous and some of them have not been fully ascertained. Disease of the liver does not disturb all hepatic functions equally. Bile cannot be collected unmixed from the intestinal contents, and there is no one test to determine all hepatic functions. Therefore single

functional tests designed to measure hepatic abnormality must be of limited value.

Combined with other tests, the Rosenthal tetrachlorphthalein test has proved of distinct value, though in some instances it has a toxic effect. The authors believe that bromsulphalein is far less toxic than tetrachlorphthalein and gives equally reliable results in the determination of hepatic function.

WILLIAM E. SHACKLETON, M.D.

Mateer, J. G., and Henderson, W. S.: Chronic Biliary Tract Disease: The Diagnostic Criteria. *Arch. Int. Med.*, 1926, xxxviii, 708.

A careful analysis of the diagnostic data in relation to the pathological findings in ninety-four consecutive cases of proved gall-tract disease shows the great importance of the clinical findings in furnishing evidence of pathological morphology of the gall tract. In forty-one of these cases gall stones were present. In thirty-six (with or without calculi) there was chronic cholecystitis with pericystic adhesions. In fifty-three there was chronic cholecystitis without stones or adhesions.

Chronic interstitial hepatitis and chronic cholangeitis with dilatation of the larger extrahepatic bile ducts was found associated with chronic gall-tract disease.

The symptoms indicative of gall-tract disease are classified into four groups: (1) anorexia, asthenia, and loss of weight; (2) arthritis, myositis, and neuritis; (3) belching, bloating, heartburn, nausea, and vomiting; and (4) localizing symptoms, particularly characteristic pain.

Physical examination aided greatly in the differential diagnosis. The most valuable sign was definite tenderness in the gall-bladder region on palpation upward under the right costal margin. Examination in the sitting position frequently aided in differentiating colon tenderness.

Cholecystography afforded reliable information in 92.6 per cent of the cases. The oral administration of the dye has proved unobjectionable and reliable in practically all cases. Bilary drainage afforded important evidence of chronic cholangeitis, and bilirubin determinations revealed liver involvement.

WILLIAM E. SHACKLETON, M.D.

Denton, J.: The Mode of Origin of Gall-Bladder Lesions. *Arch. Surg.*, 1927, xiv, 1.

This study of gall-bladder lesions was undertaken to determine by what processes some of the commonly observed lesions and pathological states of the gall bladder are produced. It was thought at first that a correlation of bacteriological and histological findings in the gall bladder would give this information, but bacteria were often cultivated from gall bladders that showed no lesions and obviously pathological gall bladders often yielded negative cultures. Much more valuable information was obtained from a study of the clinical histories, operation notes of surgeons, and the gross and histological condition of the gall bladder.

A review of the clinical histories and operation notes revealed that recent and extensive changes in the gall bladder were almost always accompanied by severe pain. Acute lesions were frequently not accompanied by a febrile reaction or an important increase in the leucocyte count. In cases of impaction of a stone in the cystic duct recent and extensive changes were usually found in the gall bladder, whereas impaction of a stone in the common duct was usually not associated with extensive gall-bladder changes.

A comparison of the gross and microscopic changes in the gall bladder in cases in which cholecystectomy was performed within two or three days after the impaction of a stone in the cystic duct made it clear that the primary lesions in the gall bladder were intramural œdema, venous distention, and an intramural hæmorrhage or intramural hæmatoma.

As it was impossible to demonstrate lesions that were primarily of bacterial origin, Denton is of the opinion that other factors than bacterial infection are necessary for the explanation of some of the commonly observed lesions of the gall bladder.

He regards the terms "acute," "subacute," and "chronic" cholecystitis as undesirable because they suggest an infectious origin of the condition. Pathological states of the gall bladder he believes should be described in morphological terms such as "œdema," "œdema and hæmorrhage," "hæmatoma," "partial infarction," "complete infarction," "œdematous cicatrix," and "cicatrix."

ARTHUR L. SHREFFLER, M.D.

Bérard and Mallet-Guy: The Syndrome of Lithiasis of the Gall Bladder Due to Chronic Inflammation of the Pancreas (Syndrome vésiculaire pseudo-lithiasique lié sans doute à l'évolution d'une inflammation chronique du pancréas). *Lyon chir.*, 1926, xxiii, 633.

Sometimes symptoms of gall stones are due to chronic cholecystitis without lithiasis, but in some cases with such symptoms no signs of inflammation of the gall bladder can be found. The authors report a case of the latter type in a woman of 24 years who at first complained of rather vague intestinal symptoms, but finally developed distinct attacks of gall-stone colic which led to the performance of a cholecystostomy. Examination through the duodenal sound showed a disturbance in bile secretion; a normal flow of bile could not be brought about by the method of Meltzer and Lyon. Duodenal examination demonstrated also defective internal secretion of the pancreas. Roentgen examination of the duodenum did not show any deformity.

A study of the gall-bladder fistula by roentgenography with the use of lipiodol showed that the gall bladder was still large and that there was a stenosis of the entire pancreatic part of the common duct. The authors believe that this method of examination gives as valuable information with regard to the bile tract as is given by pyelography with regard to kidney excretion. In the case

reported the findings of this examination and the fact that the symptoms disappeared while the gall-bladder fistula was open and re-appeared when the fistula closed up led them to perform a cholecystogastrostomy. Clinical and roentgen examination of the anastomosis showed that the bile was being excreted solely through the new opening and not by the natural route. This fact shows that there must have been some obstacle to the normal discharge of the bile.

The authors think the obstacle was the stenosis of the pancreatic part of the common duct by the chronic inflammation of the pancreas. They have been unable to determine the cause of the chronic pancreatitis and are unable to say what the outcome will be as persistence of the inflammation is indicated by continued lumbar pain which is one of the cardinal symptoms of chronic pancreatitis.

AUDREY G. MORGAN, M.D.

Counseller, V. S., and McIndoe, A. H.: Dilatation of the Bile Ducts (Hydrohepatosis). *Surg., Gynec. & Obst.*, 1926, xliii, 729.

The biliary tree of various types of the liver of man was examined by the celloidin-injection and corrosion method in twenty-six cases.

In ten normal livers the common hepatic ducts were found not to exceed 5 mm. in internal diameter, while the succeeding branches diminished in size to 0.05 mm. in the fifth order.

Of eight livers from cases in which the gall bladder contained unsuspected stones, a general enlargement of the ducts was found in seven; the dilatation in the common hepatic duct was between 6.5 and 11.5 mm. The dilatation was greater when the associated damage to the gall bladder was more severe. In the case with no dilatation, the gall bladder contained three small stones but was otherwise apparently normal.

Dilatation occurred in the liver in all of three cases in which cholecystectomy had been performed for cholecystitis with stones, eight, nine, and ten days previous to death, but was least marked in a case in which an internal fistula between the gall bladder and colon was found at operation.

In five cases of benign or malignant stricture of the common ducts, the amount of dilatation was very extensive, ranging from 10 to 30 mm. in the common hepatic duct. The process extended throughout the whole biliary tree, grossly as far as the fifth order of branches. The more complete the stricture and the longer its duration, the further out the extreme change occurred and the more abrupt the transition from dilatated branches to terminal filaments.

Attention is called to the atrophy of the hepatic parenchyma resulting from the pressure of the enlarged ducts, the obstruction to the portal venous flow from lateral biliary pressure, and the rapidity of infection from stasis.

The term "hydrohepatosis" adequately describes the condition.

Brulé: Intermittent Icterus in Calcareous or Cancerous Obstructions of the Common Bile Duct (Les ictères intermittents dans les obstructions calculeuses ou cancéreuses du canal cholédoque). *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1926, xlii, 1497.

To differentiate the icterus of chronic hepatitis from that of obstruction of the common bile duct is often difficult. To distinguish a stone in the common duct from a cancer of the pancreas or the choledochus is clinically still more difficult. So many cases show such anomalies in the symptoms or the clinical evolution that an exploratory laparotomy is unhesitatingly advised to verify the condition of the common duct. Theoretically, an obstruction from either a stone or a neoplasm of the common duct should cause an intense continuous icterus because the obstruction is permanent, yet the icterus due to stone varies more than that due to cancer. This variability is relative and based on a continuous icterus with exacerbations due to attacks of more marked biliary retention. Often an important obstacle at the common duct causes only slight icterus which is purely urobilinuric and without true biliary or urinary pigments, because the bilirubin retention in the blood is not high enough to pass the excretory threshold. In the icterus of hepatitis, urobilinuria is especially noted. At times, although the obstruction in the common duct remains, the bile retention becomes still less and may even disappear completely. Such a condition is paradoxical—permanent obstruction of the common duct with an intermittent icterus—and often leads to the delay of surgical intervention which would effect a definite cure if the obstruction is a stone. Brulé considers such cases not very unusual. He reports four with permanent obstruction of the common duct and attacks of deep intermittent jaundice lasting three or four days.

Calcareous obstruction depends on two mechanical factors—the size of the stone and the caliber of the duct. A tiny stone may block a normal duct; on the other hand, the choledochus may dilate to the caliber of the small intestine. The stone, whatever its size, will not completely obliterate the canal, the bile will flow around it. Common duct stones without icterus are not exceptional, as is well known. The additional factor of inflammation is necessary to complete the obstruction. Irritated by a stone, the choledochus, the lower end of which is usually septic, develops inflammatory attacks with swelling of the mucosa causing obstruction around the stone. Brulé considers the inflammation localized to the choledochus and not to the small bile ducts, i.e., a choledochitis rather than an angiocholitis. In his two cases of stone the attacks were associated with fever, but not with a painful liver as in angiocholitis. When the infection and swelling subside, the biliary retention clears suddenly; in hepatic cell lesions the jaundice regresses gradually. The intensity and frequency of the secondary infection regulates the appearance of attacks of biliary retention.

Two of the author's cases were cases of cancer of the pancreas. The intermittent biliary obstruction is singularly more abnormal in pancreatic cancer. Theoretically this condition should be associated with a permanently progressive icterus. To explain the intermittent jaundice the same factors are necessary as in stone: (1) incomplete obstruction by the cancer, and (2) attacks of inflammatory swelling of the choledochus at the level of the cancer set up by the irritation from the growth.

An important finding in the four cases which facilitated the diagnosis of common duct obstruction was the "accordion liver action." At each attack of biliary retention the liver was hypertrophied, smooth, of normal consistency, and painless or only slightly painful to deep pressure. When the biliary retention yielded, the liver resumed its normal size or diminished considerably. This hepatomegaly is clearly differentiated from the chronic hepatomegaly of primary liver disease. The hepatomegaly which varies with the icterus is of true diagnostic value and points strongly to obstruction of the principal bile passages. At autopsy, such an enlarged liver is gorged with bile and the dilated bile ducts form veritable cavities.

WALTER C. BURKET, M.D.

Diaz, G. L., and Duval, P. Adenoma of the Hepatic Duct with Chronic Obstructive Icterus; Removal of the Tumor and Repair of the Hepatic Duct by a Flap from the Cystic Duct; Cure (Adénome du canal hépatique; ictère chronique par rétention; ablation de la tumeur; reconstitution de la voie biliare principale par un lambeau du cystique; guérison). *Bull. et mém. Soc. nat. de chir.*, 1926, lii, 1053.

The patient whose case is reported was operated upon for supposed calculus of the common duct. At the juncture of the cystic and hepatic ducts a tumor 4.5 cm. in its longest diameter was found. The hepatic duct was dilated, having a diameter of 8 mm. It was impossible to enucleate the tumor as it was firmly fixed to the hepatic duct immediately proximal to the cystic duct. Therefore, following removal of the gall bladder, partial resection of the lateral wall of the hepatic duct and the adjacent part of the wall of the cystic duct was done. The defect in the hepatic duct was then repaired with the flap formed by the remains of the cystic duct, a sufficient space being left for the passage of a drainage tube.

The tumor proved to be an adenoma. This was believed to have arisen in the pseudo-glandular formations normally found in the walls of the bile passages.

ALBERT F. DE GROAT, M.D.

Chamberlain, D.: Acute Pancreatitis. *Brit. J. Surg.*, 1927, xiv, 390.

Acute pancreatitis, while an uncommon disease, is one of the most serious conditions occurring in the abdomen. In reviewing twenty-one cases, the author found the average age of the patients to be 50 years. The condition is more common in females than males.

Pathologically it is found that the pancreas is the site of an inflammatory swelling which becomes tense and presses on the cœliac plexus. This explains the acute nature of the pain and the severe accompanying shock. The swelling is followed by an effusion into the lesser sac of the peritoneum, which later suppurates and accounts for the fullness or swelling in the upper abdomen. The exudate finally finds its way through the foramen of Winslow, and general involvement of the peritoneum results. Scattered throughout the abdomen and elsewhere there are areas in which the pancreatic lipase liberated has saponified the neutral fats.

The infection may be due to the regurgitation of infected bile into the pancreas, lymphatic infection from the gall bladder, infection from the common duct, or foci of infection elsewhere.

The author believes that there is often an infection of the gall bladder in acute pancreatitis, and that this infection can travel to the pancreas by way of the lymphatics. Regurgitation of bile into the pancreas is not common, being usually prevented by a valve in the pancreatic duct.

Acute pancreatitis is characterized by the severity and acuteness of the onset of symptoms. Two important diagnostic signs are marked cynosis, probably due to the presence of a septicæmia, and discoloration in the flank due to a direct retroperitoneal digestion by the pancreatic ferments.

The treatment is surgical; free drainage of the peritoneal cavity is indicated. The author believes that the gall bladder should be drained in addition to the lesser sac. It may be possible to drain the lesser sac by a posterior incision resecting a portion of the tenth rib in the mid-axillary line. The drainage tube should be removed as soon as possible to prevent the formation of a permanent pancreatic fistula, but if it is removed too early and the wound is allowed to heal a pancreatic cyst is liable to develop. It is unsafe to remove the tube until the discharge has become small in amount.

From the tenth to the fourteenth day during convalescence, when the sloughs are separating, there is danger of secondary hæmorrhage. Drainage may be interfered with at this time, with a resulting return of the symptoms.

It is possible for recovery to result under medical treatment, but surgery has a lower mortality rate.

CYRIL J. GLASPEL, M.D.

Quenu, J.: The Diagnosis and Treatment of Traumatic Rupture of the Spleen (Diagnostic et traitement des ruptures traumatiques de la rate avec hémorrhagie en périoine libre). *J. de chir.*, 1926, xxviii, 393.

A favorable prognosis in rupture of the spleen depends upon early recognition of the condition and prompt intervention. The diagnosis of rupture of the spleen is based on the circumstances of the accident, usually a rather severe trauma to the left

hypochondrium. The malarial spleen and the spleen affected by various diseases such as thyroid, pneumonia, tuberculosis, etc. is very liable to rupture even with moderate trauma. There is a state of shock often with an initial syncope. The author says, "Delayed syncope following an abdominal trauma by several minutes, hours, or days, especially if the trauma was sustained in the left hypochondrium, is an almost pathognomonic sign of rupture of the spleen; it means that the injured spleen begins again to bleed, and constitutes, to my mind, a formal indication for operation."

Pain is an important symptom, especially so if it is intermittent. It is located most frequently in the left hypochondrium, but in 10 per cent of the cases occurs in the left shoulder. Rigidity in the left upper quadrant is probably the most valuable sign. In some cases, however, rigidity may be generalized or absent. Dulness is also an important sign, but is often absent because of meteorism. Acceleration of the pulse, even when moderate, is an indication for operation, but its absence does not justify delay.

The temperature is subnormal at first, but soon rises and tends to remain around 100.4 degrees F., which the author considers almost pathognomonic of the condition. Vomiting and urinary retention are not very valuable signs. Laboratory aids are of little value except as indicators of the amount of hæmorrhage. Various types of clinical courses are described in detail. The diagnosis is made in about 23 per cent of cases, and the diagnosis of internal hæmorrhage is about 10 per cent more. The condition may be confused with peritonitis, perforated appendix, perforated gastric ulcer, ruptured tubal pregnancy, or diaphragmatic pleurisy. Rib fracture is present in about 15 per cent of the cases, hæmothorax in probably more than 5 per cent, and injury to the left kidney in 10 per cent.

The treatment is splenectomy as soon as the diagnosis is made or suspected. If the diagnosis is made the author recommends an incision which gives good access to the spleen, starting at the left costal margin at the eighth interspace and descending obliquely downward toward the umbilicus. If hæmothorax is present he advises continuing the incision upward to the costal margin, cutting through the rib cartilages, and converting the operation into a thoracolaparotomy. Blood transfusion may be indicated postoperatively, but the author does not recommend the practice of leaving the blood in the peritoneal cavity or of re-injecting it intravenously. Conservative measures, such as suture, partial splenectomy, or tamponade, are hazardous and in the main useless. As a rule no lasting ill effects follow splenectomy, but in some cases the loss of the spleen at a time when the patient is already weakened may have fatal consequences.

The author reviews 353 cases reported in the literature since 1885, and reports nineteen additional cases. The article is supplemented by an extensive bibliography. MICHAEL L. MASON, M.D.

MISCELLANEOUS

Aumont and Grégoire: Severe Contusion of the Abdomen with Disinsertion of the Mesentery; Immediate Resection of the Right Half of the Colon; Open Fracture of the Patella (Contusion abdominale grave; desinsértion mésentérique, hémicolectomie droite d'urgence; fracture ouverte de la rotule). *Bull. et mém. Soc. nat. de chir.*, 1926, lii, 1055.

The patient whose case is reported was injured in an automobile accident. At operation, performed immediately, the distal 20-cm. portion of the ilium was found torn from its mesentery and the meso of the ascending colon presented an irregular tear. Resection of the portion of injured ilium and of the proximal half of the colon was done. A diffuse hæmorrhage from the posterior abdominal wall was arrested by the placing of a Mikulicz drain.

The open fracture of the patella which the patient had sustained was treated by suture ten days after the accident. No infection developed in the knee.

The patient made a satisfactory recovery.

In the discussion of this report there was criticism of the delay in the treatment of the fracture as the experience of the war showed that joint lesions should be operated upon immediately, regardless of the associated injuries. ALBERT F. DE GROAT, M.D.

Bérard and Dunet: Roentgenography of a Subphrenic Abscess (Radiographie d'un abcès sous-phrénique). *Lyon Chir.*, 1926, xxiii, 651.

After transdiaphragmatic drainage in a case of subphrenic abscess an injection of about 50 c.cm. of lipiodol mixed with 30 c.cm. of sterilized oil was made through a Nélaton sound which was easily slipped between the convex surface of the spleen and the diaphragm. The roentgenogram showed a very tortuous cavity with many diverticula on the convex surface and at the upper pole of the spleen. The abscess extended to the midline with many processes, and the roentgenogram shows how difficult it would be to drain it.

The roentgenogram is valuable in such cases as it shows the surgeon just where drainage and counter openings should be made.

AUDREY G. MORGAN, M.D.

Bérard and Dunet: Hæmatoma of the Iliac Fossa in a Hæmophiliac; Operation Followed by Severe Hæmorrhage; Intravenous Injection of Citrate; Recovery (Hématome de la fosse iliaque chez un hémophile; intervention suivie d'hémorrhagie grave; injection citratée intraveineuse; guérison). *Lyon chir.*, 1926, xxiii, 622.

The patient whose case is reported was a boy of 18 years who was sent to the hospital with a probable diagnosis of sarcoma of the pelvis. An exploratory operation revealed a large hæmatoma of the iliac fossa. The family history, obtained after the operation, showed undoubted maternal hæmophilia. At 3 years of age the patient was treated for

what was called a white swelling of the knee, and at various times thereafter he had attacks of pain in the ankle and wrist joints which were called articular rheumatism. These were probably attacks of hæmophilic arthritis as they appeared and disappeared quickly, leaving the joints perfectly normal. Recently the patient began to have difficulty in walking which became worse until he was unable to extend his thigh completely and walked bent forward.

Examination revealed a large swelling in the left ilac fossa. The interference with movement of the hip joint seemed to be purely mechanical. Operation showed a large hæmatoma from which a large quantity of black clots was removed. The effusion of blood had occurred between the iliac muscle and the bone and extended backward and upward to the posterior superior spine of the ilium. There was no abnormal oozing during the operation, and as the coagulation time was normal the wound was closed.

For twenty-four hours convalescence was normal, but at the end of that time the iliac swelling began to recur rapidly and an infiltration of blood appeared over the whole right half of the abdomen, in the inguinal canal, the right scrotum, and the penis. The wound was therefore opened and firmly tamponed, but the oozing did not stop and the blood would not coagulate; pulmonary complications and a labial herpes with hæmorrhagic contents of the vesicles developed. As a preliminary to blood transfusion, an intravenous injection of 15 c.cm. of citrase (a solution of sodium citrate combined with citrate of manganese, magnesium, and ferri-potassium tartrate) was given. After a period of extreme shock with cyanosis and tachycardia of 180 to 190 for two hours, the patient recovered. The next day the oozing had stopped and his general condition was so good that transfusion was unnecessary.

AUDREY G. MORGAN, M.D.

Brady, L.: Solid Tumors of the Urachus. *Arch. Surg.*, 1927, xiv, 46.

BRADY reviews the literature on solid tumors of the urachus and reports one case of his own, bringing the total number of recorded cases up to twenty.

The average age of the patients was 44 years. These tumors have been found more frequently in men than in women. In fourteen case reports no etiological factor was mentioned. In four cases the tumor developed from the walls of a urachal cyst. The symptoms were pain in the middle of the lower abdomen and, when the bladder was involved, dysuria, polyuria, and hæmaturia.

Eighteen of the tumors were malignant, seven being sarcomata and eleven carcinomata. In fourteen of the eighteen cases of malignant tumor the bladder was invaded by the growth when the patient first sought treatment. It is often difficult to distinguish clinically between a malignant tumor of the urachus and an inflammatory condition of the anterior abdominal wall due to infection of urachal remains or urachal cysts. However, in inflammatory conditions, pain is apt to be the first symptom and fever and night sweats soon occur.

To effect a cure in a case of malignant urachal tumor a very radical operation must be performed. As a rule this must include removal of the vertex of the bladder and of portions of the anterior abdominal wall.

ARTHUR L. SHREFFLER, M.D.

GYNECOLOGY

UTERUS

Young, M., and Stewart, C.: Cancer of the Uterus. *Lancet*, 1926, ccxi, 1258.

This is a statistical study of 214 cases of carcinoma of the uterus with special attention to the end-results of operation.

Ninety per cent of the patients were traced for five years (or until the date of death) and some longer than that. Since cancer of the corpus uteri is much less malignant than cancer of the cervix, these two groups are considered separately. There were 176 cases of cervical carcinoma and thirty-eight of cancer of the body of the uterus. In both of these groups both palliative and radical operations were performed.

The mortality of radical removal of the uterus in cancer of the cervix is relatively high, but the end-results of this operation are so favorable that at the end of four years the number of survivors is four times, and at the beginning of the sixth year, nine times, the number in comparable groups in a large series of cases permitted to run their course without treatment. Furthermore, the figures for cases of cancer of the body of the uterus treated by radical operation suggest an even more favorable result than is obtained in cancer of the cervix treated in like manner.

A study of the figures presented by the authors show that the age of the patients who have cancer of the corpus uteri is about five years higher than that of patients with cervical cancer. It shows also that the number of children borne by the women with cervical cancer was about twice the average number borne by women with cancer of the corpus uteri.

PAUL W. SWEET, M.D.

Heimann, F.: Pre-Operative X-Ray Irradiation of Carcinoma of the Uterus (Antecoperative Roentgenbestrahlung des Uterus-carcinoma und ihre Tiefenwirkung). *Zentralbl. f. Gynack.*, 1926, l, 1945.

The author first attempted to improve the operative results in cancer of the uterus by pre-operative irradiation. He tried all types of roentgen technique and although from the first there was a decrease in the ill-smelling discharge and the previously ulcerative bleeding craters became covered over with smooth epithelium, he could demonstrate no change in the bacterial flora. He is therefore of the opinion that pre-operative irradiation will not render the operation any safer in the sense that it deprives the bacteria of their nourishing medium—a view contrary to that held by Mayer of Tuebingen and Fuerst of Zurich.

The most significant effect of the irradiation is that a parametrium which before the treatment was greatly infiltrated, after the irradiation was soft and normal to the touch as the result of the regression of the inflammation.

As to the choice of time at which to operate after irradiation, the author's investigations showed that this is a perplexing question inasmuch as the deeper carcinoma cells are not affected by the treatment. The time should be that which permits the most favorable effect of the irradiation and will not delay operation sufficiently to favor dissemination of the cancer cells.

Heimann rejects the use of radium and mesothorium for pre-operative treatment as these substances cause technical difficulties in the operation. He has never seen any complications following X-ray irradiation. The operation was at no time rendered more difficult and connective tissue changes were never seen. Hæmorrhage was no more profuse than is usually the case. The skin closed perfectly.

The author would reserve pre-operative irradiation for selected cases since, between the time of irradiation and the operation, the viable cells can still proliferate and reduce the chances of success.

SCHUMACHER (G).

ADNEXAL AND PERIUTERINE CONDITIONS

Tuffier, T.: An Attempt to Protect the Ovaries During the X-Ray Treatment of Uterine Fibroids (Essai sur la protection des ovaires dans le traitement des fibromes utérins par les rayons-X). *Presse méd.*, Par., 1926, xxxiv, 1473.

Roentgen therapy is thoroughly established as a method of treating uterine fibroids, but its results must be considered from two points of view, viz., the relief of the symptoms and the disappearance of the tumor.

Experience indicates that the disturbances due to the fibroid cease when the function of the ovaries is abolished. Thus X-ray treatment is in reality a non-operative castration. Certain roentgenologists have succeeded in arresting the hæmorrhages with doses not destructive to the ovary, but the constancy of the results and the duration of the cures remain to be determined.

When it becomes possible to relieve the symptoms, cause regression of the fibroid, and at the same time preserve the ovarian function the value of X-ray therapeusis will not longer be debatable. In the cases of young women in whom it was desirable to preserve genital function but myomectomy was not feasible Tuffier attempted to protect the ovaries during the period of X-ray treatment. The following method was found successful:

When the exploratory operation showed the impossibility of enucleation the author enclosed each

ovary in a bivalved lead capsule having on one side an opening to accommodate the ovarian pedicle. The edges of the valves were perforated to allow their approximation by sutures. The lead capsule was 4 mm. thick, lined with aluminium to prevent secondary irradiation, and coated with paraffin. Following the X-ray treatments the capsules were recovered at a second operation. This method has been employed in three cases:

A patient 29 years old was found at operation to have a soft fibroid the size of the head of a newborn infant. As enucleation did not seem justifiable and the patient would not permit destructive operation, a capsule was placed over each ovary and fixed to the lateral portion of the broad ligament.

After several X-ray treatments the abdomen was again opened (six days after the first operation) and the capsules were removed. The ovaries appeared normal in every respect. Profuse metrorrhagia of two days' duration followed. Thirty-eight days later the patient menstruated for three days, and a month later again menstruated normally. About this time it was found that the tumor had increased in size and hysterectomy was deemed advisable. The tumor was found to be a myoma with a rapid growth. There were no structural changes that could be ascribed to the irradiation. This case evidently represents a failure of X-ray therapy.

In a second case multiple fibroids which could not be enucleated were found. The same procedure was followed without incident. Normal menstruation was re-established, but again the irradiation had no apparent effect on the size of the tumor.

The third case was very similar to the second. Normal menstruation was restored but there was no reduction in the size of the tumor.

The author believes that the method described is indicated in certain types of cases and might be extended to protect other sensitive organs such as the adrenals. ALBERT F. DE GROAT, M.D.

Cotte, G., and Bertrand, P.: Three Cases of Implantation of the Tube into the Uterus (Trois cas d'implantation tubo-utérine). *Lyon chir.*, 1926, xxiii, 660.

The authors report three cases in which it was necessary to resect a part of a fallopian tube on account of adhesions. The tube was then implanted into the uterus. The cornu of the uterus having been curetted, a needle threaded with catgut was passed through the fundus of the uterus and out at the cornu and the catgut was used to pull the end of the tube down into the cavity of the uterus. The tube was fixed in the uterus with two non-perforating sutures.

This operation has been objected to on the ground that the anastomosis may become obliterated secondarily and that it forms a point of least resistance at which rupture may occur in pregnancy. While implantation through an incision of the anterior wall might leave a scar that would predispose to rupture, the authors do not believe that the slight trauma of their operation could have any such result. They admit the possibility of obliteration of the anastomosis, but examination with lipiodol in their cases has shown the tube to be permeable; in one case it was found permeable five months after the operation. Some cases of pregnancy after this operation have been reported in the literature, but pregnancy has not yet occurred in any of the authors' cases.

AUDREY G. MORGAN, M.D.

Hartmann, J. P.: The Treatment of Non-Tuberculous Adnexal Affections (Die Behandlung nicht tuberkuloeser Adnexleiden). *Acta obst. et gynec. Scand.*, 1926, v, 254.

This article reports upon 353 cases of non-tuberculous adnexal affections treated during the period from 1917 to 1923. A re-examination was made in all except eight.

Hartmann emphasizes that conservative treatment such as the use of gonococcal vaccine, protein therapy, treatment with turpentine, and diathermy should be tried in every case. However, he has not had much experience with these measures. The best results from conservative treatment (recovery in 63 per cent of the cases) were obtained in acute conditions. In chronic cases conservative therapy resulted in recovery in only 45.9 per cent. In the acute cases the cure seemed to be independent of the extent of the lesion, whereas in the chronic cases the extent of the lesion was a factor influencing recovery. The patient's social circumstances were found to be of far less importance than was expected.

Operative treatment was avoided as much as possible in the acute cases, but was believed to be indicated in the chronic cases in which the condition had made the patient an invalid and recurrences were frequent. The patient's social circumstances and age were taken into consideration. The various operative procedures are discussed—colpotomy, removal of one tube, removal of both tubes and one ovary, and total extirpation—and the technique for liberation of the adnexa and Faure's hemisection and drainage is described.

The best results were obtained from radical treatment. Of the 353 patients, 117 were treated surgically with three deaths. In the surgically treated cases recovery resulted in 81.28 per cent, whereas in those treated conservatively recovery resulted in only 55.5 per cent.

The author believes that conservative treatment is often overdone.

Ahlström, E.: The Treatment of Non-Tuberculous Adnexal Inflammations (Die Behandlung nicht tuberkuloeser Adnexentzuendungen). *Acta obst. et gynec. Scand.*, 1926, v, 291.

In a review of 1,552 cases of salpingitis treated at the Sabbatsberg Hospital in the period from 1919 to 1923, exclusive of cases of tuberculous salpingitis, the author found that life-threatening conditions occurred in at least forty-one (2.6 per cent), most of

which (forty) were cases of septic salpingitis. In more than half of these cases (twenty-one) the condition was related to pregnancy (abortion, usually induced, and in a few cases delivery and extra-uterine pregnancy), but in the rest no such relationship could be proved (nineteen in 1,363 such cases of salpingitis, 1.4 per cent).

In the cases of gonorrhœal salpingitis, life-endangering conditions were rare. In 477 cases there was one death from ileus, a mortality of 0.2 per cent, and if secondarily infected cases are included, there was an additional death from septic peritonitis, making two fatalities in 490 cases, a mortality of 0.4 per cent.

The author discusses the septic types of salpingitis and the complications and conditions calling for operation in the period of fever. The primary and end-results in the rest of the cases—the majority—in which conservative treatment was possible and those in which operation was done later in an afebrile stage have been reported by Holtz in *Acta gynecologica Scandinavica*, Vol. iv, Nos. 3 and 4.

The relatively high incidence of life-endangering conditions should not be allowed to influence the indications for operation in the sense of the routine performance of an operation in the acute stage, as has been proposed by certain gynecologists.

In the acute cases the author has given expectant treatment first and has operated only upon the appearance of a life-threatening condition or, in certain cases, to prevent the development of such a condition. When these rules were followed the total mortality was 2 per cent. If we exclude the few cases of postpartum salpingitis and the cases of abortion in which latter the mortality is highest and the condition is so severe that it usually ends fatally whatever the treatment, the mortality was only 0.9 per cent.

The author is of the opinion that it is impossible to obtain better results by operation performed during the stage of fever. According to most statistics, the effect of such treatment is very much poorer as regards both the primary and the end-results.

Aside from the rare cases of life-threatening complications in gonorrhœal salpingitis and the cases incorrectly diagnosed (appendicitis, extra-uterine pregnancy, twisted ovarian tumor), it is chiefly the cases of septic salpingitis which call for operation in the stage of fever.

In the majority of the cases the process becomes walled off, and in some of them a cure is obtained by conservative treatment. Sometimes an intraperitoneal or adnexal abscess is formed which can be incised without opening the abdominal cavity by colpotomy or laparotomy just above Poupart's ligament. Not infrequently it may be necessary to make several such incisions. Except in severe septic cases following abortion the prognosis under such treatment is good. After from one to six years, 77 per cent of the patients were cured, 6 per cent had only slight complaints, and 16 per cent had recurrences. Six per cent had become pregnant. The persistence of a fistula is rare.

Even when it is necessary to open the abdominal cavity, operation is indicated in salpingitis with localized peritonitis under the following conditions:

1. When, at the beginning of treatment, the symptoms of septic infection are so severe that the condition appears dangerous, as in cases of large pus pockets. In such cases the condition is usually a recurrence. As the extirpation of these pus pockets may be very difficult because of adhesions and friability of the parametrium, it is best, especially when there are other unfavorable circumstances (such as adiposity, cardiac weakness) to treat by incision and drainage rather than excision and to do this in two stages if possible.

2. When the local swellings increase or do not decrease and the symptoms of septic infection persist or increase with deterioration of the general health, weakening of the pulse, a high fever, and repeated chills and vomiting, and when the salpingitis is a non-puerperal infection. In such cases the condition is often a recurrence and operation must be undertaken to prevent the development of diffuse peritonitis such as occurred suddenly in several of the cases reviewed, with or without rupture of the adnexal abscess. The operation should consist in extirpation of the adnexa if the patient's condition will allow it; otherwise, in incision of the abscess and drainage.

3. When the general condition deteriorates so that it is apparent that death will result from chronic infection if operation is not undertaken. In such cases the condition is often tuberculosis with generally a secondary infection. As Wetterdal has pointed out on the basis of the author's material (*Acta gynecologica Scandinavica*, Vol. iii, No. 3), it is seldom that the fever persists after two months if tuberculosis is absent. When there is fever after this length of time, operation should be performed even if the condition does not appear dangerous to life, and the attempt should be made, in spite of technical difficulties, to extirpate the adnexa whether the condition is a septic infection or tuberculosis or both, since otherwise there is no prospect of cure. In addition, drainage should be established unless there are definite indications that the condition is tuberculosis without secondary infection.

When there are symptoms of diffuse peritonitis, when peritoneal symptoms spread more or less quickly in the hypogastric region as far as or even beyond the umbilicus, and when the general condition, the pulse, and recurring chills and vomiting indicate that the peritonitis is of a septic nature, operation should be performed without delay. Also in peritonitis following abortion or delivery the attempt must be made to operate if, as is not infrequently the case, the condition appears hopeless on account of pyæmic symptoms. The operation must be restricted to laparotomy with evacuation of the pus and drainage; such patients are unable to withstand extirpation of the adnexa.

EXTERNAL GENITALIA

Westman, A.: The Results of the Treatment of Cancer Vaginæ at Radiumhemmet, Stockholm. *Acta radiol.*, 1926, vii, 632.

The author gives an account of the radiological treatment of twenty-one cases of cancer of the vagina. After a period of obervation of from six to twelve months, five (23.8 per cent) of the patients were free from symptoms. Three of the cases were operable, three were borderline cases, and the rest were inoperable. Of twelve patients re-examined after five years, two (16.7 per cent) remained clinically cured. The condition of one of the latter was operable and that of the other inoperable.

MISCELLANEOUS

Westman, A.: A Contribution to the Question of the Transit of the Ovum from the Ovary to the Uterus in Rabbits. *Acta obst. et gynec.*, Scand., 1926, v, Supp.

The author first briefly reviews the topographical anatomy of the internal genital organs in different mammals. Then follows an account of the various theories regarding the transit of the ovum from the ovary to the tube and those regarding its transit through the tube. Of the former, the theory of the ciliary currents and Sobotta's theory of the importance of the bursa ovarica and the function of the unstriated muscle of the adnexa are cited in detail. Of the latter, particular reference is given to the activity of the ciliary cells and the peristaltic contractions of the tubal musculature.

By the "abdominal window" method, the author has carried out investigations on the tubes of rabbits. In his operative technique in these studies the part of the abdomen in which the internal genital organs are situated was shut off from the rest of the cavity by suturing the cæcum to the anterior and posterior walls. In this manner the intestines, which normally cover the tube and ovary, were moved out of the way and an obstructed view of the organs was obtained.

Observations were made on animals during their sexually quiescent period as well as during œstrus and gestation. During the quiescent period there are to be noted in the musculature of the mesotubarium fairly weak contractions occurring at relatively long intervals which draw the entire tube medially and caudally, thereby rendering it more looped and the bursa ovarica narrower. During these contractions the immobile ovary becomes more or less enclosed in the bursa. In the tube, continuous contractions occur. These pass over the ampulla for shorter or longer distances toward the uterus, but in the looped isthmus they usually proceed only from one apex to the next one on the uterine side. A contraction then follows in the next loop, a continuous wave being thus set up in the direction of the uterus. Contractions having an antiperistaltic course may also be observed occasionally. The contractions are as a rule followed by more or less obvious dilatations. The intervals between the contractions in one and the same loop vary from five to thirty seconds.

During œstrus, fundamentally the same movements of the tube and mesotubarium are observed. They differ, however, in intensity and rhythm. The mesotubarial movements are very powerful and cause considerable constriction of the bursa ovarica. The ligamentum ovarii proprium is the site of rhythmical contractions drawing the ovary out and in of the narrowed bursal opening. In addition, the ovary is rotated to and fro around its long axis. The displacements of the tube and ovary cause the various surfaces of the ovary to slide uninterruptedly along the fimbrial apparatus. Contractions and dilatations in the tube are well marked; the intervals of time between them vary between five and twelve seconds.

Muscular contractions of a similar type can be observed during the first twenty-four hours after fertilization, but then become reduced in intensity and rhythm. They are considerably weaker during gravidity than during the quiescent period.

The muscular activity of the tube and the ligamentum latum is regulated by the ovary. The contractions are weak after castration and after destruction of the ovarial follicles by heat. They are strongest during œstrus when ripe follicles are in existence. The corpus luteum has a retarding influence on the strength and rhythm of the contractions.

It is probable that through alternate contractions and dilatations in the tube a powerful suction is set up. It has been demonstrated experimentally that this suction may effect a movement into the tube of ova present in the free abdominal cavity which have been discharged from an ovary and fixed at some distance from the infundibulum. External migration of the ovum is also possible. The transit of the ovum seems to be considerably facilitated by the approximation of the infundibulum and the ovary during œstrus and ovulation by the muscular activity of the ligamentum latum. In addition to its other uses, the bursa ovarica probably serves as a protective device.

During œstrus, this is closed round the ovary off and on and the mesotubarial contractions set up a suction in the bursa by which smaller particles present in the abdominal cavity can be brought in close approximation to the abdominal ostium of the tube. However, it is not necessary for the bursa to be intact for the transit of the ovum as this may occur even after the bursa has been partially extirpated.

The transit of the ovum through the tube is probably effected chiefly by muscular contractions. After follicular rupture, these are very powerful but later become weaker. Theoretically this may explain the fact that the passage of the ovum is rapid through the abdominal part of the tube but greatly retarded through the uterine part.

Jung, P., and Schirmer, A.: The Combination of the Pneumoperitoneal Roentgen Picture of the Female Pelvic Viscera with Hysterosalpingography (Ueber die Kombination des Pneumoperitonealen Roentgenbildes der weiblichen Kleinbeckenorgane mit der Hysterosalpingographie). *Acta radiol.*, 1926, v, 395.

In simple roentgenograms of the female pelvic organs made with the induction of pneumoperitoneum there are difficulties to interpretation, particularly with respect to the relationship of the pelvic organs to neighboring organs. If pneumoperitoneum is combined with injection into the uterus and tubes of an opaque substance such as lipiodol, the interpretation of the roentgenograms is greatly facilitated, particularly in cases of adnexal affections and tubal pregnancy and the differentiation of adhesions and disease conditions in neighboring organs.

For testing the patency of the tubes, salpingohysterography alone has a great advantage over simple tubal inflation in that it renders the tubes visible. It therefore reveals something of the nature and location of any obstruction that may be present and gives more complete information with regard to the shape and degree of development of the uterus.

In the diagnosis of intra-uterine changes—tumors and other irregularities in the mucous membrane—these methods are excellent substitutes for the not harmless dilatation and palpation. In 150 cases the authors noted no unfavorable after-effects.

OBSTETRICS

PREGNANCY AND ITS COMPLICATIONS

De Nobele and Lams: The Effect of the Roentgen Rays on the Evolution of Pregnancy and the Development of the Fetus (Action des rayons roentgen sur l'évolution de la grossesse et le développement du fœtus). *Brit. J. Radiol.*, 1926, xxxi, 449.

Various reports have been made of the birth of abnormal children after roentgen-ray treatment of the mother during pregnancy. In order to study this effect of the X-rays the authors irradiated guinea pigs and rats during pregnancy.

They found that irradiation with an erythema dose generally killed the embryo. The more penetrating the rays the more marked the effect. The earlier in pregnancy the irradiation was given the surer it was to cause the death of the embryo. If the embryo was not killed in the beginning of the irradiation, its later development was abnormal. There were no abortions, but the evolution of the pregnancy was stopped and the embryos were absorbed. The irradiation would probably have caused abortion if it had been given during the latter part of the pregnancy as in the experiments performed by Schinz on rabbits. In guinea pigs, the irradiation seemed to produce ovarian cysts. The embryos that were carried to term showed lesions of the nervous and sensory systems, such as hydrocephalus and microphthalmus which could not have been transmitted by heredity. AUDREY G. MORGAN, M.D.

Laffont and Mélé: The Transplacental Passage of Staphylococci in a Fatal Staphylococcus Infection Complicated by Meningitis (Passage du staphylocoque par voie placentaire au cours d'une staphylococciémie mortelle avec méningite). *Bull. Soc. d'obst. et de gynéc. de Par.*, 1926, xv, 566.

A woman 24 years of age was admitted to the hospital on April 28, 1926, for nervous disturbances complicating pregnancy. The pregnancy had been normal until April 20 when symptoms of premature labor began. Opium was then administered.

After four days the patient's family noticed that she had difficulty in speech and weakness in the right leg and arm. Two days before her admission to the hospital she developed facial paralysis and vomiting occurred. The temperature was 39 degrees C. Examination at the time of the patient's admission revealed signs of meningitis. Lumbar puncture withdrew spinal fluid containing pus.

Without waiting for a laboratory examination, an injection of anti-meningococcus polyvalent serum was given. The laboratory report showed staphylococcus meningitis.

On May 4 a blood culture was positive for the staphylococcus. On May 6 the patient became comatose and delivered herself of a female child weighing 1,425 gm. The child died half an hour later. On May 7 the patient died with bulbar paralysis.

After the death of the child its heart was punctured, a thermocauterization of the cardiac wall being performed. On culture of the blood extracted from this cavity a growth of staphylococcus was obtained. This showed that the septicæmia and meningitis had been transmitted transplacentally from the mother to the child.

SALVATORE DI PALMA, M.D.

Benckert, H.: A Case of Gravidity in a Uterine Diverticulum. *Acta obst. et gynec. Scand.*, 1926, v, 430.

Benckert's case of pregnancy in a uterine diverticulum occurred in a woman aged 33 years who had had a normal parturition in 1912. In 1917 she had had a uterine curettage on account of irregular and persistent bleeding of unknown etiology. In 1920 another curettage was done for a mucous polypus in the corpus.

After the last operation the patient menstruated normally. Her last period began January 1, 1922. On February 1, some drops of blood were lost. At the time of examination on February 8 the size of the uterus suggested a pregnancy in the seventh week.

Five weeks later, when the patient was seen again, she had been having, for two weeks, a chocolate-colored discharge from the vagina and pain in the lower part of the abdomen. Examination revealed, besides the discharge, a uterus which was moderately tender on palpation and as large as a uterus at the beginning of the third month of pregnancy.

On the patient's admission to the hospital, a dilatation and curettage was done. The scrapings were extremely scanty and there was little evidence of an ovum. Microscopic examination of the scrapings showed them to consist of mucous membrane cells, the stromatic cells of which had assumed a decidual character. A diagnosis of incomplete abortion was made.

Just before the patient was to be discharged from the hospital, an internal examination was made. This revealed, close to the right uterine angle, a soft, fluctuating, tender, and movable mass the size of a goose egg. Laparotomy showed, on the right side at the tubal angle, a thin-walled sac about the size of an apple, which was filled with fluid and contained a fetus 9 cm. long. This sac communicated with the uterine cavity through a canal about the size of a pencil. The excised sac was found to contain a typical placenta with decidua and villi.

HARRY W. FINK, M.D.

Brinkley, A. S.: The Management of Acute Abdominal Complications During Pregnancy. *Virginia M. Month.*, 1926, liii, 591.

Fibromyomata with a twisted pedicle, ovarian cyst with a twisted pedicle, pyosalpinx, incarceration in the pelvis of the retroverted gravid uterus, infection and inflammation of Meckel's diverticulum, peritonitis, intestinal obstruction, ruptured or unruptured extra-uterine pregnancy, acute appendicitis, and pelvic abscess complicating pregnancy demand immediate operation, whereas acute cholecystitis and gastric or duodenal ulcer should be treated palliatively, if possible, until after the termination of the pregnancy.

The conservative treatment of pyosalpinx during pregnancy is unwise because labor will almost certainly rupture the sacs. ALBERT W. HOLMAN, M.D.

LABOR AND ITS COMPLICATIONS

Trillat, P.: A Special Position of the Head of the Fetus in Breech Presentation (De l'existence d'une attitude particulière de la tête fœtale dans les présentations de siège). *Gynéc. et obst.*, 1926, xiv, 211.

According to the classical textbooks on obstetrics the head of the fetus in breech presentation is in more or less marked flexion, the chin rests on the sternum, and the two parietal eminences are at equal distances from the two acromion processes. The head is therefore in a condition of unstable equilibrium which causes cephalic ballottement. One of the best signs of the presence of the head in the fundus is the accentuated throat groove.

Several years ago the author's attention was attracted to a special position of the head in breech presentation, occurring especially in the incomplete form. This consists in rotation with forced inclination of the head. The child's hands rest on its flexed knees and the head is turned to one side, the cheek and side of the head resting on the backs of the hands. The rotation and inclination vary in degree. In very marked cases one of the parietal eminences rests on the wall of the chest, the ear being in contact with the sternum. The top of the head looks forward.

Trillat first discovered this position when he was trying to extract a child presenting by the breech. He had extracted the breech and brought down the arms, but could not find the mouth in the usual position. He discovered the ear in contact with the sternum and to find the mouth was obliged to pass his hand far around toward the extremity of the transverse diameter. He thought this was simply an isolated case until a colleague told him some months later of a similar one. He then made a systematic study to determine the frequency of the position. In his material at a maternity hospital since May, 1925, he has had thirty-six breech presentations, twelve of them complete and twenty-four incomplete. In the twelve complete breech presentations, inclination and rotation of the head occurred in only one (8.3 per cent), while in the twenty-four incomplete breech presentations it occurred in eight. In two cases the inclination was very great, in three moderate, and in three slight. Half of the mothers were primiparæ.

The position described presents difficulty in diagnosis because cephalic ballottement and the throat groove are absent, it is impossible to practice version by external maneuvers, and the chin may catch on the symphysis. AUDREY G. MORGAN, M.D.

Zarate, E.: Partial Symphysiotomy and the Symphysiotomy of Frank (La symphysiotomie partielle et la symphysiotomie de Frank). *Gynéc. et obst.*, 1926, xiv, 289.

The author calls attention to the fact that his subcutaneous symphysiotomy is a very different procedure from the operation of Frank. It is more than a simple modification of an old technique and its indications and possibilities should be visualized from a different standpoint. The method of Frank is a blind, open, dangerous operation and seems to favor complications rather than to prevent them. The structures which oppose a rapid and complete separation of the pubic bones are sectioned blindly.

In the author's technique an intra-articular section of the cartilage and of the inferior ligament is performed with a scalpel and separation of the bones is accomplished by forced abduction of the thighs. The operation is bloodless and safe, demands only ordinary operative skill, and may be done under local or general anæsthesia.

Zarate's pelvitomy should not be considered a substitute for the low cæsarean section. Pelvitomy is indicated only in pelvic dystocia in which the conjugata vera is more than 8 cm. When the conjugata vera is less than 8 cm., cæsarean section finds its application.

The patient is placed in the dorsal position with the legs strongly abducted. Before the operation the upper border of the symphysis is marked without displacing the skin surface. With the left index and middle finger in the vagina, the fetal head is pushed upward and to one side. A 4.5-cm. scalpel is then introduced vertically just missing the upper border of the symphysis to enter the fibrocartilage of the symphysis. The fibrocartilage is sectioned from above downward, the scalpel always being kept within the articulation. The sensation imparted by the cartilage, which contrasts with the sensation produced by contact with the ligaments, serves as guide. The section is made with a rotary motion to avoid enlarging the initial opening in the anterior ligament. The pubic bones usually separate with a cracking sound and the separation can be increased as necessary by forced abduction made by the assistants supporting the legs. If necessary, the superior ligament may be sectioned. A separation of two fingerbreadths may be expected, and it is possible to obtain one of three fingerbreadths. Labor is ordinarily allowed to proceed normally. The knees are bandaged together for the first four days.

The patient is then allowed to move about in bed, and on the twelfth day she is allowed to get up.

ALBERT F. DE GROAT, M.D.

Lundquist, B.: A Contribution to the Knowledge of the Etiology of Colporrhexis. *Acta obst. et gynec. Scand.*, 1926, v, 408.

The author reports the case of a 43-year-old para-iii. The patient's first two labors had been normal. External examination at the beginning of her third labor at term revealed a vertex presentation with the head engaged in the pelvic brim. The membranes ruptured three and a half hours after the onset of labor. On external examination three hours after rupture of the membranes the head was found engaged just below the plane of the ischial spines with the anterior fontanelle presenting. The cervix was retracted. The pains were fairly strong, but half an hour later they weakened and the patient became restless and vomited. There was no external bleeding. The pulse was 110 and the fetal heart sounds were good.

The pains soon ceased altogether, the pulse rate rose to 140, and the fetal heart sounds ceased. Peritoneal irritation was evident. In the abdomen it then became possible to feel two large swellings united in the middle, the left one as large as a man's head and the right one smaller. At the umbilicus a small fetal part could be palpated close under the abdominal wall. A diagnosis of rupture of the uterus was made.

At laparotomy the fetus was found lying free in the abdomen. The head remained fixed in the pelvic brim. The uterus was found torn from the anterior vaginal fornix from the site of the left uterine artery to the region just behind the right uterine artery. The arteries themselves were uninjured. Death occurred from sepsis. The cause of the rupture in this case was not a mechanical factor but some condition of the tissues, probably the suppurative endometritis and myometritis.

In the vaginal tissues remaining on the uterus there were abscess-like accumulations of leucocytes and in one or two areas evident demarcation zones of leucocytes. In the opinion of the pathologist, the inflammatory process had been present for two or three days before labor. ROLAND S. CRON, M.D.

PUERPERIUM AND ITS COMPLICATIONS

Descarpentries: On the Results Obtained with Hæmolyzed Autogenous Blood in the Different Types of Puerperal Fever (Considérations sur les résultats obtenus par l'autosang hémolysé dans les diverses modalités de la fièvre puerpérale). *Bull. Soc. d'obst. et de gynéc. de Par.*, 1926, xv, 569.

The author reports several cases of puerperal fever treated with hæmolyzed autogenous blood.

The technique is not described, but Descarpentries states that it is quite different from the usual autogenous hæmotherapy, the latter having the effect of the injection of a foreign protein while in his method there is never any shock and the effect is due to an "unknown substance." He emphasizes that the red blood cells must not be killed before lysis for if this occurs a reaction similar to that following the injection of a foreign protein is produced.

The results obtained vary according to the organism responsible for the infection.

In three cases of puerperal fever due to streptococci, treatment by the author's method resulted in a quick complete cure. In two cases due to staphylococci the results were excellent but were obtained less promptly. The result was good also in a case due to the gonococcus. In a case due to the colon bacillus, death resulted. In a case due apparently to a spirillum the use of autolyzed blood and arsenical treatment was followed by recovery.

The most serious type of puerperal infection is that due to the colon bacillus.

In the discussion of this report, PAUCOT stated that, in his opinion, colon bacillus infection is the least serious type. SALVATORE DI PALMA, M.D.

NEWBORN

Floris: Birth Trauma and the Fate of Infants Extracted with Forceps (Il trauma da parto ed il destino dei bambini estratti col forcipe). *Riv. ital. di ginec.*, 1926, iv, 651.

The author examined the infants extracted with forceps at his clinic during the period from January 1, 1910, to December 31, 1924, and attempted to find out what became of those that were discharged living and well. The immediate mortality was 15.09 per cent. Gans reports the mortality as 12.45 per cent, and Schmarsow gives it as 9.2 per cent. In the statistics of eighteen obstetricians collected by Winter it ranged from 6.9 to 27.7 per cent, whereas in those of eight obstetricians collected by Wyder it ranged from 20 to 56 per cent. The author's statistics are based on a relatively small number of cases; forceps extraction was done only on the strictest indications.

In the author's cases the mortality from the first to the tenth day was 4.02 per cent. Of the children examined at periods ranging from one to fourteen years after birth, 57.4 per cent showed more or less manifest lesions of the scalp or skull from the pressure of the blades of the forceps. There was one case of convulsions in the first year of life and one case of choreiform movements and tic which began during the first year and still persisted in the sixth year. Of the lesions found, 74.07 per cent were on the right side and 25.93 per cent on the left side.

AUDREY G. MORGAN, M.D.

GENITO-URINARY SURGERY

ADRENAL, KIDNEY, AND URETER

Rowntree, L. G.: Some Contributions to Our Knowledge of Diseases of the Kidney and Liver. *Canadian M. Ass. J.*, 1926, xvi, 1437.

During the last two decades the author's personal observations and studies have led him to an altered conception of disease and to greater effort for individualization in treatment. Because of the functional deficiency evidenced in disease and its widespread and constitutional nature, he is no longer satisfied with morphological, cellular, or even visceral conceptions of pathology. Such a conception of disease must of necessity affect the therapeutic viewpoint and tend toward the adoption of treatment for the prevention and correction of perverted function, and of treatment based, when possible, on the response of the sick person to various functional and therapeutic tests.

By the judicious repetition of tests of renal function the progress of disease may be followed accurately, the outcome predicted, and the treatment modified to meet changing conditions. The information derived from the various tests will reveal whether or not the kidney is involved; the nature of the disturbance, nitrogen or salt-water metabolism; the occurrence of terminal insufficiency common to several pathological processes; and the classification of cardiorenal vascular syndromes (Volhard and Fahr). The points of prognostic significance revealed are the degree of renal insufficiency, the course of the disease, and the probable outcome, especially in chronic disease.

The points revealed with regard to treatment are its urgency, the indications as to its kind and degree, the extent of risk in surgical cases, and the indications for individualization.

Changes in the composition of the blood are of great significance in the investigation of the organs of excretion. The function of these organs is to keep the volume and the composition of the blood constant. Deviation from the constant usually indicates disease of the excretory organs. Besides revealing changes in nitrogenous metabolism, studies of the blood chemistry yield important information relative to acidosis and alkalosis and disturbances of the acid-base equilibrium of the body. The extent of anæmia may therefore be of great practical significance in relation to diagnosis and prognosis as well as to the treatment.

Few realize the importance of the ophthalmoscope and of the still more recent microscopic studies of the capillaries of the nail folds in cardiorenal vascular disease. The fundus of the eye yields more pathognomonic pictures of disease than any other area of the same size in the body. The capillaries of the nail fold also exhibit pictures which give information regarding disease, especially the constitutional nature of nephritis and of its complications.

The prognosis in cardiorenal vascular disease is rendered much more accurate by the use of functional tests which indicate the extent of renal insufficiency and the proximity of uræmia. By repeating the tests it is possible to follow the course of the disease. The phenolsulphonephthalein, blood-urea, and creatinin tests have an important prognostic significance in chronic disease.

There is no routine treatment for nephritis. In fact, the most striking development in the treatment is the tendency to forsake the routine for individual treatment based on the behavior of the patient to various functional and therapeutic tests.

In the treatment of œdema there is a growing appreciation of the influence of different ions on the hydration capacity of body tissues. In cases of anasarca the fluid intake, aside from that of food, must be reduced to from 200 to 300 c. cm. daily. The introduction of a new organic mercury compound, merbaphen (novasurol), has created new interest in the management of œdema. In suitable cases, when given intravenously in doses of 2 c. cm. at intervals of from three to five days, it often causes unprecendented diuresis. The clinical results are excellent, and toxic manifestations infrequent.

The work of McIndoe and Counseller has emphasized the bilateral nature of the liver, the remarkable dilatation of the biliary tree, the hydrohepatosis resulting from obstruction of the common duct, and the inadequacy of the portal vascular system in cases of portal cirrhosis.

Mann and Magath have succeeded in maintaining life in dogs for a period of from thirty-six to forty hours after removal of the liver. In these animals hypoglycæmia develops with convulsions and death unless the blood sugar-level is maintained by the administration of glucose. This work is significant in relation to hypoglycæmia in general and suggests the use of glucose in forms of toxæmia associated with hepatic insufficiency. In a dehepatized animal, de-amidization is remarkably disturbed and the nitrogen and urea of the blood diminish simultaneously. On the other hand, uric acid accumulates in the blood. There is also retention of serum bilirubin with an indirect van den Bergh reaction and the development of jaundice.

Important indicators of hepatic function are: (1) the serum bilirubin (van den Bergh); (2) the bile index; (3) dye retention, tetrachlorphthalein or bromsulphthalein; (4) the bile salts in the blood and urine (?); (5) the coagulation time of the blood; (6) the fragility of the corpuscles; and (7) bile and

its products in the urine, stools, and duodenal contents.

In diagnosis the tests reveal: (1) whether or not the liver is diseased; (2) whether or not there is jaundice and its nature—whether it is obstructive or hæmolytic—and whether the terminal picture is common to several pathological processes; and (3) the classification of hepatic diseases. In the prognosis these tests aid in determining the degree of hepatic insufficiency, but this is of slight value in foretelling the course of the disease.

Daily contact with disease of the liver and group investigations of the problems presented demonstrate the practical importance of these tests in diagnosis and treatment. Thus far, however, their greatest service has been in the centering of interest on diseases of the liver.

Factors relating to prevention are the care of acute infectious and chronic foci, especially intra-abdominal foci; care relative to the use of alcoholic condiments, chloroform, arsenic, phosphorus, copper, phenylhydrazin, and tar; and care in industry with phosphorus, "aeroplane dope," and picric acid.

Specific factors relating to treatment are the use of constitutional specifics such as arsphenamin, iodide, mercury, emetin, quinine, vermicides, and of hepatic specifics such as water, glucose, and calcium. Functional factors are the relief of biliary obstruction by transduodenal drainage; the relief of ascites and portal obstruction by surgical treatment (the Talma-Morrison operation, splenectomy, or paracentesis) or by medical treatment (merbaphen, ammonium salts, or restriction of salt and water); the relief of hæmolysis by splenectomy; the relief of congestion by digitalis, diuretics, and restrictions of salt and water; and protection from hæmorrhage in jaundice by the use of calcium, transfusions, carbohydrates, and water. Symptomatic factors are the relief of pruritus by calomel, emetin, diathermy, and sweating, and the relief of gastro-intestinal disturbances by diet and sedatives.

Perhaps the most important advances in treatment have been made in the management of ascites in disease of the liver. Whereas, formerly, tapping was usually resorted to, it is now apparent that in a considerable percentage of cases the ascites yields to merbaphen.

Hunt, V. C.: Hydronephrosis. *Surg. Clin. N. Am.*, 1926, vi, 1153.

Hydronephrosis is one of the most common lesions of the kidney. It is usually the result of an intermittent type of obstruction of the renal pelvis or the ureter. The obstruction may be either extrinsic or intrinsic.

The most common cause of extrinsic obstruction is an accessory vessel or group of vessels to the lower pole obstructing the outflow of urine at the ureteropelvic juncture. In most instances the accessory vessels include both artery and vein and vary considerably in size. They may extend to the upper pole, but are more frequently noticed at the lower pole because there they produce obstruction on account of their relationship to the ureter and pelvis. Experience has shown that ligation and division of accessory vessels to the lower pole has been inadequate and that primary nephrectomy is more satisfactory. Occasionally pelvic and abdominal tumors causing obstruction by encroaching on the ureter are encountered. In such cases of moderate hydronephrosis the symptoms will usually subside after removal of the obstruction.

Intrinsic obstruction is most often caused by a renal or ureteral calculus. If the kidney becomes badly diseased or functionless, nephrectomy, or nephro-ureterectomy to a point below the stone, should be carried out. It is difficult to determine the part played by ureteral strictures in the production of hydronephrosis except when the stricture is situated at the ureterovesical juncture; a ureteral stone may be secondarily responsible for the obstruction. It is possible that ureteral stricture may be a factor in the so-called idiopathic type of hydronephrosis in which no demonstrable obstruction is found, but in such cases the possibility of compression by accessory vessels should not be too readily dismissed.

Klason, T.: Cystic Kidneys (Ueber Zystenniere). *Acta radiol.*, 1926, vii, 65.

The author describes the pyelograms in two cases of polycystic degeneration of the kidney with reference to the findings at operation and autopsy.

On a pyelogram of such a kidney the renal pelvis is situated more in the center of the renal shadow than normally. The pelvis is not enlarged in relation to the size of the kidney; on the contrary, it is rather narrowed from side to side by the intrusion of the cysts. The infundibula are out of proportion and irregularly arranged. The uppermost part of the ureter is displaced medially. The abnormal position of the ureter is due to the enlargement of the kidney, and the altered position of the renal pelvis to the cysts surrounding it on all sides.

Atonna, C., and Morrissey, J. H.: Polycystic Kidney. *Ann. Surg.*, 1926, lxxxiv, 846.

The authors state that about 500 cases of polycystic kidney have been reported in the literature. They report six cases of their own. Three types are recognized:

1. Those in which renal insufficiency appears and the patient quickly succumbs. These cases, which are discovered at autopsy, illustrate the fact that only an extraordinarily small amount of kidney tissue is necessary to sustain life.

2. Cases presenting symptoms of chronic nephritis. The diagnosis is difficult if the cysts remain small.

3. Cases in which symptoms such as hæmaturia and clot colic direct attention to the urinary tract. Four of the cases reported in this article belonged to this group.

According to the authors, the value of pyelography as an aid to diagnosis cannot be overestimated. The

method must be used with caution, however, because of the possibility of reflex suppression. Immediately after the examination the patient should be put to bed. Heat should then be applied to both kidneys and a colonic irrigation given. The most efficient surgical treatment has been puncture or incision of the cysts. As a rule medical treatment is the method of choice.

Several typical pyelograms are reproduced.

HARRY A. FOWLER, M.D.

Mercier, O., and Pérard, J.: A Case of Profuse Hæmaturia from Pyelonephritis Stopped by Ureteral Catheterization (Un cas d'hématurie abondante de pyélonephrite arrêtée par le cathétérisme urétéral). *J. d'urol. méd. et chir.*, 1926, xxii, 304.

A woman of 29 years entered the hospital March 3, 1926, on account of a profuse hæmaturia which began January 28. The hæmaturia was apparently total and began spontaneously with clots. There were no other symptoms. On May 10, 1924, the patient had had a right nephrectomy for tuberculosis with hæmaturia.

Palpation of the kidney was negative. Cystoscopy showed the bladder normal; fresh blood was being discharged from the opening on the left ureter.

As medical treatment had only a slight effect, catheterization of the left ureter was decided upon. A sound was passed into the pelvis and a few cubic centimeters of 1 per cent silver nitrate solution were injected. The sound was then immediately withdrawn. That evening the urine became normal in color. Bacteriological examination showed pus containing many colon bacilli. The hæmaturia was stopped permanently and the patient left the hospital a few days later.

This case demonstrates that a late hæmaturia after nephrectomy for tuberculosis does not necessarily mean a return of the tuberculosis; it may be due, as in this case, to a colon-bacillus infection. It shows also the readiness with which such hæmaturias can be stopped by catheterization of the ureters. This is the first treatment to be tried in such a case. If it is successful it confirms the diagnosis.

AUDREY G. MORGAN, M.D.

Matronola, G.: Statistics on Renal Tuberculosis (Dati clinico-statistici sulla tubercolosi renale). *Arch. ital. di urol.*, 1926, iii, 129.

Of 125 patients with renal tuberculosis who were treated at the Policlinic in Rome, nine were between 10 and 20 years of age, fifty-five between 20 and 30, thirty-eight between 30 and 40, fifteen between 40 and 50, six between 50 and 60, and two between 60 and 70. Therefore 73 per cent were between the ages of 20 and 40 years. Sixty-seven were females. Eighty-nine (70 per cent) were operated upon. Among the thirty-six not operated upon, operation was contra-indicated in twelve because the tuberculosis was bilateral and in six by co-existent pulmonary tuberculosis. One patient died before operation from tuberculous meningitis and seventeen refused operation.

In addition to the eighty-nine clinic cases which were operated upon the author reviews fifteen from Matronola's private practice, making a total of 104. Fourteen (13 per cent) of these patients died in the hospital. This is not the operative mortality, however, for with the exception of the cases of three patients who died within a few days after the operation, the deaths occurred after periods ranging from a month to a year. The cause of death in these cases was renal insufficiency in six, infection in three, tuberculous meningitis in two, and an unknown cause in three.

Of the ninety patients who were discharged with an operative cure, it has been possible to follow up only fifty-four. Fifteen are dead. Of these, five died after less than a year, six after from one to three years, one after five years, one after six years, one after nine years, and one after ten years. The majority of them therefore died within three years. The cause of death so far as it could be ascertained was tuberculosis of the other kidney in nine, pulmonary tuberculosis in two, bone tuberculosis in one, and an unknown cause in three. The thirty-nine patients who are still living were operated upon from one year to fourteen years ago. Twenty-seven have no symptoms now, but twelve have bladder symptoms such as pollakiuria, pyuria, and more or less intense hæmaturia.

The results have not been poor considering that renal tuberculosis is a disease which is fatal in the majority of cases. Most of the patients who are cured have no symptoms worth mentioning and are able to do their work. One man has been through the war and is still in active military service and enjoying good health. One woman, who is now well and able to do her work, has been married twice since the operation and has had two pregnancies ending in abortion. Another woman was subjected to an abdominal hysterectomy for fibroids ten years after the nephrectomy and bore the operation well. In the patients under 50 years of age the mortality was between 33 and 44 per cent, while in those between 50 and 60 years of age it rose to 83 per cent, showing that the disease becomes much more serious with advancing age. AUDREY G. MORGAN, M.D.

Söderlund, G.: A Contribution on the Roentgen Diagnosis of Renal Tuberculosis (Beitrag zur Frage ueber die Roentgendiagnostik der Nierentuberkulose). *Acta radiol.*, 1926, vii, 504.

The author has reviewed the histories of 162 cases of renal tuberculosis examined with the X-rays in the period from 1912 to 1925. The findings of the examination were positive in fifty-two, and in twenty-nine of these were of definite value in either the diagnosis or the treatment. Söderlund divides these twenty-nine cases into the following six groups:

Group 1. Both ureters catheterized. No tubercle bacilli found in the urine from the bladder or the

ureters. No definite tuberculous changes in the bladder. Six cases.

Group 2. Catheterization of the ureter of the healthy kidney only. No tubercle bacilli found in the urine from the bladder or the ureter. No definite tuberculous changes in the bladder. Four cases.

Group 3. Catheterization of the ureter on one side in three cases; pus and tubercle bacilli found. Catheterization on both sides in one case; tubercle bacilli found on only one side; tuberculosis also in other kidney shown by X-ray. Four cases.

Group 4. Cystoscopy impossible because of stricture or narrowing of the urethra. Six cases.

Group 5. Catheterization of the ureters impossible because of changes in the bladder. Four cases.

Group 6. Enclosed renal tuberculosis; at time of examination no communication of tuberculous process in kidney with the bladder. Five cases.

The author describes the X-ray changes observed in these fifty-two cases.

In no fewer than forty-two cases, shadows of calcification due to the tuberculous process appeared on the plate in areas corresponding to the kidneys and ureters, and in thirty-one of these the shadows were so characteristic as to permit a diagnosis of renal tuberculosis on the basis of the X-ray examination alone. In two cases the nature of the shadows was uncertain, and in nine the appearance seemed more like that of lithiasis.

In one of the remaining ten cases with positive X-ray findings, there were impressions in the renal shadow at the hilus and the lower pole. In another, pyelography established the presence of a cavity. In two cases, cavity formations were manifested by double contours of the renal shadow. In one case a thickened ureter was found. In two cases the examination revealed dilatation of the pelvis, and in three cases the renal shadows on the affected side were enlarged.

Marion: Pyelography in the Diagnosis of Tumors of the Kidney (La pyélographie dans le diagnostic des tumeurs du rein). *J. d'urol. méd. et chir.*, 1926, xxii, 310.

Marion has previously called attention to the mistakes that may be made in the diagnosis of tumors of the kidney from pyelography. In this article he reports the case of a man who had repeated attacks of hæmaturia. Aside from a slight decrease in the function of the left kidney which was the one that was bleeding, examination showed nothing but pyuria without bacteria. The latter suggested tuberculosis, but the hæmorrhage was more copious than is usual in tuberculosis. A pyelogram showed no sign of tumor. The author advised operation because he thought the condition was either tuberculosis or tumor. However, the patient feared operation and went to Legueu who concluded from pyelography and catheterization of the ureters that there was no urgent need of an operation.

Subsequently the patient had another attack of hæmaturia and consulted Abrami. Abrami also advised surgery. At operation, Marion found a papilloma of the pelvis which it seemed should have shown in the pyelogram but did not. He therefore concludes that pyelography is of no value in the diagnosis of tumor in a hæmorrhagic affection in a kidney which is not increased in size. It may show no evidence of tumor when a tumor is present or it may show evidence of tumor when there is nothing but clots.

In a case of hæmaturia with clots not due to tuberculosis, calculus, hydronephrosis, or pyelonephritis, an exploratory operation should be performed without pyelography.

In cases of large kidney without hæmaturia, pyelography will show whether the kidney is enlarged from tumor or some other cause.

AUDREY G. MORGAN, M.D.

Marion: Mistakes That May Be Made in the Performance of Nephrectomy on the Basis of Constant Alone (Des erreurs auxquelles peut entrainer le principe de la néphrectomie sue la constante). *J. d'urol. méd. et chir.*, 1926, xxii, 327.

This article reports two cases in which a double exploratory laparotomy was performed on the basis of Ambard's constant alone and the kidneys were found macroscopically normal. Later cystoscopic examination in the first case showed nothing to indicate that the cystitis was tuberculous, and functional examination of the kidneys showed them both to be normal. In the second case a later examination showed an ordinary bilateral pyelonephritis and lesion of the epididymis suggesting tuberculosis. However, there was nothing to indicate that an operation on the kidney would be advisable.

Marion has previously warned against the performance of kidney operations on the basis of the constant alone, and these two cases are a further support of his argument. A nephrectomy based on the constant alone is justified only if the diseased side is definitely known and it is necessary to remove the diseased kidney even if the opposite kidney is not altogether normal. Marion cites as an example a case of large, painful, and evidently pyonephrotic kidney and perinephritis on one side and a good constant. Even if the opposite kidney is involved in such a case, the pyonephrotic kidney must be removed if the opposite kidney is still sufficient or death will result. In a case in which one kidney is known definitely to be tuberculous but there is nothing special to indicate its removal except the tuberculosis, and in which the constant shows that the other kidney is sufficient but there is nothing to prove that it is intact, the kidney known to be tuberculous should not be removed as the other kidney may be affected as much or even more although it does not manifest its involvement so plainly upon clinical examination.

AUDREY G. MORGAN, M.D.

BLADDER, URETHRA, AND PENIS

Campbell, M. F.: Bladder Dysfunction Secondary to Nerve Lesions. *Canadian M. Ass. J.*, 1926, xvi, 1487.

Disturbances of bladder function may occur as a reflex from peripheral sources of irritation or may be secondary to lesions of the central nervous system. In some cases, bladder irritation may be cured by removal of the cause of peripheral irritation. In cases of lesions of the cord, and especially in tabes, the vesical symptoms are often the first to appear, and their proper treatment is very important in increasing the patient's comfort and prolonging his life even when the nerve lesion is incurable.

The author outlines his treatment of bladder symptoms which is applicable to all cases of cord lesion and particularly to tabes. After the diagnosis is established, urotropin in combination with acid sodium phosphate is given in quantities sufficient to keep the urine alkaline—doses ranging from 10 to 15 gr. three times a day to considerably larger amounts. After the amount of residual urine has been determined, every attempt is made to prevent vesical distention and to allow the bladder to regain its tone. If the residual urine is less than 3 oz., catheterization twice a week is enough; if it is under 5 oz. catheterization must be done every two days, whereas if it is more than 5 oz., catheterization must be done every day. If there is acute retention, catheterization every eight hours is necessary. After the bladder is emptied it is washed out with an antiseptic solution, either 1:5,000 acriflavine or silver nitrate of the same strength.

While the infection of the bladder is being combated and the amount of residual urine reduced, re-education of the bladder mechanism is attempted. The bladder is filled and the patient ordered to void. He is then instructed to practice starting and stopping urination several times during each voiding. Although this may be impossible at the first few trials, it is amazing how many patients acquire a new control.

The underlying cause of the cord condition must, of course, be treated, and in lues great care must be exercised that the treatment of the late stages is not too intensive as compared with that of early syphilis. HENRY L. SANFORD, M.D.

Hunt, V. C.: Bilocular Diverticulum of the Urinary Bladder. *Surg. Clin. N. Am.*, 1926, vi, 1153.

Diverticula of the bladder are now recognized as a not infrequent cause of urinary difficulty, frequency, and retention. It is probable that in most instances the diverticula are not congenital in origin, but result from mechanical obstruction at the neck of the bladder or of the urethra. They seldom occur in the female, probably because the short female urethra is very seldom the site of stricture or obstruction, which are conditions of frequent occurrence in the male.

The most common site of the opening of the diverticulum is near one of the ureteral orifices, but only rarely does the ureteral orifice empty into or give way to the formation of a diverticulum. The ureter and the wall of the diverticulum are frequently in intimate relationship, but it is rarely necessary to ligate the ureter in order to extirpate the sac. Diverticula are usually single, but in about one-third of the cases they have been multiple.

Surgical removal is indicated when they fail to empty with the bladder. Geraghty has described a transvesical method which is applicable to diverticula situated in the dome or the lateral walls. The larger diverticula require extravesical extirpation on account of the inflammatory reaction in the peridiverticular tissues. The best results following extirpation of diverticula are obtained by removing the primary obstruction.

A case of multilocular diverticulum in a man aged 65 years is reported. The opening of the diverticulum was about 1 cm. in diameter and situated about 1.5 cm. above the right ureteral orifice. The capacity of the diverticulum was twice the capacity of the bladder.

When the diverticulum was elevated for extravesical extirpation a smaller diverticulum 5 cm. in diameter was found communicating with it; the smaller one was apparently a diverticulum of the larger one.

Hager, B. H.: Clinical Data on Alkaline Incrusted Cystitis. *J. Urol.*, 1926, xvi, 447.

Hager reports the results of a further study of alkaline incrusted cystitis, reviews the literature, and gives an account of the cases seen in the past ten years at the Mayo Clinic. He considers this disease established as a distinct entity. The causative organism is now named "proteus ammoniæ" but was formerly placed with the salmonella. The probable source of this organism is the intestinal tract. Trauma or mild infection is necessary to prepare the field. Clinically, the condition under discussion is characterized by chronicity, the symptoms of severe cystitis, and the passage of gritty, alkaline urine containing mucus, pus, and a disproportionate amount of blood. Frank hæmaturia may occur. In spite of the severity of the local disease, the patient's general condition is usually excellent. For diagnosis, cystoscopy is invaluable, though generally the bladder is irritable and bleeds readily and its capacity is reduced. Anæsthesia may be necessary.

Inspection reveals single or multiple areas covered with hard incrustations firmly embedded in and adherent to the mucosa. Removal of the incrustations exposes bleeding areas of granulation tissue which may be studded with fine concrements. These areas may be flat or papillomatous in appearance. Between the incrusted areas a grayish membrane is frequently found on the mucosa. It is composed of mucus, cell débris, and blood cells and is readily removed by irrigation.

Bladder neoplasm impregnated with urinary salts, leucoplakia, and true vesical calculus must be considered in the differential diagnosis. A biopsy is necessary when a neoplasm is strongly suspected. Leucoplakia has a characteristic appearance. True calculus and incrusted cystitis may coexist.

The meager literature consists mainly of reports of isolated cases. Interest has centered in symptomatic therapy, including operative or endoscopic removal of incrustations, local applications to the ulcerated areas, irrigations, and attempts to acidify the bladder contents.

At the Mayo Clinic fifty cases have been seen in the last ten years. Thirty-four of the patients were females. The average age of the males was 52 years and that of the females 35 years. The latter age is significant as it falls within the child-bearing period. The urine was alkaline except in one case in which the disease was limited to two small areas of the bladder neck. All except one of the women were married. The unmarried woman had an associated pyelonephritis. In the case of a boy of 17 years examination revealed a large vesical calculus and a mass of concrements filling the entire urethra. Though the average duration of symptoms in the series was roughly three years, evidence is presented that incrusted cystitis may run a protracted course up to fifteen or twenty years. Infection in the upper urinary tract may coexist, though technical difficulties frequently prevent its investigation. Of twenty-six cases in which ureteral catheterization was carried out, only five showed definite pyelonephritis. The available evidence indicates that, in women, catheterization and trauma at parturition are contributing factors. In the male the greater incidence of the disease at the age of greatest frequency of prostatic conditions suggests trauma as a factor.

Six patients in the series were completely cured, two died from influenza, and twenty-six were benefited (disappearance of the incrustations, reduction of the symptoms). Five did not have sufficient treatment, and the condition of seven was unchanged. In four cases the condition was inadequately checked before the patient left the hospital. Two patients required suprapubic cystostomy for relief.

The treatment has varied greatly. Bacillus bulgaricus emulsion, at first in great favor, gave a few good results. Many cases required, in addition, curette removal of the incrustations with acetic lead irrigations. It is possible that the bulgaricus tablets did not always yield live cultures. Attempts at acidification of the urine by the administration of the usual drugs proved futile. The best results were obtained by removal of the incrustation by curette with the application of strong silver nitrate to the raw areas. The treatment is still symptomatic and the prognosis favorable only when prolonged treatment is possible. Now that the etiology of alkaline incrusted cystitis is understood, there is hope of attaining a specific treatment.

Cecil, H. L.: Sarcoma of the Bladder: Report of a Case in Which a Total Cystectomy Was Done. *J. Urol.*, 1926, xvi, 471.

The author reports a case of sarcoma of the bladder in which a complete cystectomy was done and followed by recovery. He has been unable to find in the literature any similar case with recovery.

The patient's chief complaints were pain in the left kidney and blood in the urine. His family history and personal history were negative. The illness began July, 1923—seven months before he consulted the author—with hæmaturia lasting three or four days. The urine then became clear. Several months later there was another attack of hæmaturia which was more profuse than the first. Since that time blood had been constantly present in the urine in varying amounts. Two months previously the patient had a severe pain in the left kidney region, which radiated down the course of the ureter to the bladder. Three weeks previously he began to have pain in the bladder and pain on urination.

Physical examination was negative except for a mass in the lower abdomen about 12 cm. wide and extending about 7 cm. above the symphysis. Rectal examination revealed in the region of the bladder a large mass which was soft, boggy, and painful. The seminal vesicles, vasa deferentia, and prostate were pushed downward and backward and apparently not involved. Cystoscopic examination was impossible because the bladder was completely filled with blood. The phenolsulphonephthalein test was 65 per cent at the end of two hours. As the tumor was movable, large, and soft, a probable diagnosis of sarcoma of the bladder was made. X-ray therapy was advised.

After a month and a half of intensive irradiation the patient's condition became very much worse. There was marked frequency, urination occurring about every fifteen minutes and associated with considerable pain. This persisted night and day. The patient had lost between 30 and 40 lbs. The tumor had grown considerably, but was still movable. X-ray examination showed calcareous deposits on the bladder wall. As a palliative measure, suprapubic cystostomy was done. The tumor, which was blue in appearance and covered with large veins, was found to occupy the entire anterolateral and most of the posterior bladder walls. The trigone and vesical orifice were free. There was considerable hæmorrhage following the operation. Microscopic examination of the section removed showed sarcoma.

The tumor continued to grow very rapidly and protruded through the wound. Another series of extensive X-ray treatments was given and the tumor was fulgurized on six different occasions. In spite of all, it continued to grow and protrude through the wound, but at no time showed any tendency to invade the surrounding structures. Because of its rapid growth, radical surgery was resorted to. On June 23 the right ureter was implanted about 1½ in. above and to the inner side of the anterior superior spine. On July 7 a similar procedure was

carried out with the left ureter. On July 28 a total cystectomy was done. The tissues which were in apposition to the tumor were excised with a wide margin. The bladder was freed by blunt dissection and removed just above the prostate.

The convalescence was rather stormy. The huge cavity left by the tumor required frequent irrigation with Dakin's solution. Toward the end of his convalescence the patient had pain in the left kidney region and a few days later and on several other occasions passed fragments of stone. One year after the operation he was in good health, of normal weight, and enjoying life. The urine was caught by silver cups and collected in a rubber bag worn between the legs. No local recurrence nor metastases could be made out. One year and nine months after the removal of the bladder a large recurrence was found on the left side at the outer border of the rectus. On May 1, 1926, this tumor mass, which was firmly adherent to the pubis, was removed entirely with the cautery. The pathological examination of the bladder showed the surface to be slightly lobulated. No evidence of ulceration could be made out. The orifices of the ureter and the trigone are not involved. The entire anterior, superior, and left lateral walls are involved. Microscopically the tumor was made up of irregularly arranged cells which conformed to two rather different types. Mitotic figures were present but not numerous. The tumor was classed as a fibroblastic sarcoma.

Pathologically sarcomata of the bladder vary from small polypoid masses to large papillomatous or smooth masses. They are occasionally covered by normal mucous membrane. Ulceration is rare. The tumors occur more frequently in the very young and persons past middle age. Tumors having a pedicle generally have a very wide pedicle which involves the bladder wall and apparently arises from the submucosa or intermuscular substance. The growth of the tumor is characteristically very rapid. Most authorities believe that these very malignant tumors metastasize rather late. They usually arise close to the vesical orifice or on the trigone, and very commonly invade the ureters. The microscopic picture varies considerably in different cases. All of the growths are very vascular. Cecil has been unable to find mention of a case in which tumor cells were found lying within a blood vessel wall. The most common type has been the round cell sarcoma. The cause of death in these cases is the toxæmia which results from the infection in the bladder and kidneys.

Of the various symptoms, pain is the most prominent. It is usually associated with urination. Because of the relatively late occurrence of ulceration, hæmaturia is apt to be a late symptom, but is usually marked. An early diagnosis is even more important in sarcoma than in epithelial tumor of the bladder as the former is much more malignant than the latter. The symptoms of the two conditions are very similar. Cystoscopic examination offers the most help in the diagnosis. If the cystoscopic examination alone is not sufficient, microscopic examination of a piece of tissue excised from the tumor will probably clear the diagnosis. Before any radical treatment is attempted, roentgenograms of the skeletal system should be taken to rule out metastases.

Complete resection is the only method of treatment which offers any hope. The adjacent tissues should be removed with the tumor. X-ray and radium irradiation should be tried only in cases which are inoperable. In the late cases, which do not respond to irradiation, total cystectomy is the only treatment. In the performance of cystectomy, the disposition of urine is a problem. Theoretically the most ideal procedure is a nephrostomy, but this is a very uncomfortable type of wound. In the author's case, ureterotomy gave good results. Of the various complications due to marked involvement of the surrounding tissues, pyelonephritis is the most common. In all but eight cases, the treatment of sarcoma of the bladder has been unsuccessful. Of three patients subjected to total cystectomy, two died.

ALTON OCHSNER, M.D.

Cassuto, A.: Explosion in the Bladder in the Course of an Electrocoagulation (Explosion dans la vessie au cours d'une électrocoagulation). *J. d'urol. méd. et chir.*, 1926, xxii, 263.

The author was destroying a hypertrophied middle lobe of the prostate by electrocoagulation with a MacCarthy cysto-urethroscope when a loud explosion suddenly occurred. As the tumor was rather large and not very vascular, he was using a current of 400 ma. When the accident happened he had closed the irrigating part of the apparatus, leaving about 150 c.cm. water in the bladder. After the explosion he carefully withdrew the cystoscope and injected a small amount of water. All of the water returned, showing that there was no rupture of the bladder. He therefore decided on expectant treatment instead of immediate operation. No signs of peritonitis of phlegmon of the space of Retzius developed. There was only a little more hæmaturia than is normal in such operations, the bleeding continuing until the fifth day. A cystoscopic examination on the eighth day revealed a red and œdematous mucous membrane with deep fissures.

The current used in electrocoagulation causes the formation of many small gas bubbles which can be seen clearly through the cystoscope. The author believes that these gas bubbles are a product of the disintegration of cells. The gas is evidently of a type that explodes readily when a certain volume of it accumulates in the bladder and is acted upon by a current of a certain intensity. In the use of endoscopes with continuous irrigation of the type employed by the author the gas bubbles are usually carried off by the return current of water. Cassuto attributes the accident in his case to the use of a current of 400 ma. and the fact that he had cut off the irrigator, leaving from 100 to 150 c.cm. of water in the bladder. To prevent such accidents he

recommends that not more than from 300 to 350 ma. be used and that the irrigation be kept up continuously. He regards currents of 500 ma. as very dangerous. The failure of the explosion to cause rupture of the bladder in his case was explained by the fact that there was only a small amount of water in the bladder and not much gas had accumulated.

Three months after the accident the patient reported that he was in excellent condition and his bladder emptied completely.

AUDREY G. MORGAN, M.D.

Fedoroff, S. P.: Total Excision of the Bladder for Malignant Tumor (Sur la question l'ablation totale de la vessie dans les cas de tumeurs malignes). *J. d'urol. méd. et chir.*, 1926, xxii, 370.

Fedoroff urges more radical treatment of malignant tumors of the bladder. Total excision of the bladder is not a complicated procedure and if it is done in two stages is not especially dangerous. In the first stage the ureters are transplanted, preferably into the lower curvature of the sigmoid colon. In the second stage, performed two or three months later, the bladder excision is done.

The author reports twelve cases, all of which were "neglected cases." Pyelitis had developed in eleven. In two, the pyelitis caused death. Two patients died before the second stage of the operation was performed. Two died of a generalized metastasis, one of them after five years and the other after one year and two months. Two deaths were due to accidental causes not attributable to the operation. In all, there were eight deaths. Of the four living patients, two are in perfect health six years and two years respectively after the operation. The two others, who were operated upon about a year ago, have pyelitis.

Fedoroff maintains that even in cases of small carcinoma with few signs of infiltration, total excision of the bladder offers surer relief from suffering and prolongation of life than any other operation.

MICHAEL L. MASON, M.D.

Duboucher and Michon: A Case of Traumatic Rupture of the Perineal Urethra Treated by Immediate Urethrorrhaphy (Un cas de rupture traumatique de l'urètre périnéal traité par l'urétrorraphie immédiate). *Bull. et mém. Soc. nat. de chir.*, 1926, lii, 1214.

A young man sustained a rupture of the perineal urethra in a fall in which he landed astride of a beam. The injury was followed by severe pain, a bloody urethral discharge, retention of urine, and swelling of the perineum. At operation, performed immediately, suprapubic cystostomy was followed by repair of the urethra. The latter was extremely difficult, because of the continuous bleeding, the crushed and friable condition of the tissues, and the difficulty in finding the perineal end of the urethra. It finally became necessary to re-open the bladder incision and employ retrograde catheterization. The catheter was made to bridge the defect in the urethra, and an end-to-end suture was done.

Healing took place by first intention, and the cystostomy closed at the end of forty days. The end-result was good.

It is considered advisable to repair perineal lacerations of the urethra immediately. Simple cystostomy is inadequate. While it is sufficient in the majority of ruptures of the membranous urethra, involvement of the perineal portion requires incision, the evacuation of clots, and end-to-end repair.

LEO M. ZIMMERMAN, M.D.

Verriotis, T., and Defrise, A.: Inflammatory Neoplasms of the Posterior Urethra in Chronic Gonorrhœa (Sur les néoformations inflammatoires de l'urètre postérieur au cours de la blennorragie chronique). *J. d'urol. méd. et chir.*, 1926, xii, 273.

Inflammatory changes in the posterior urethra, especially those due to gonorrhœa, show two types of endoscopic picture. In the first there is an inflammatory erythema, and in the second there are destructive processes causing craters or proliferating processes producing excrescences.

There are two kinds of excrescences, one due to œdematous infiltration and the other due to hyperplasia of the epithelial cells and the subepithelial connective tissue. The excrescences from œdematous infiltration look like those of bullous œdema but are vascularized and less transparent. They are seen in the first stages of subacute inflammation or in the beginning of recurrences. The excrescences due to hyperplasia are papilliform or polypoid and the latter may be sessile or pedunculated. They are found almost anywhere in the posterior urethra and around the orifice of the bladder, and, more rarely, in the membranous urethra. They are generally smooth and almost transparent or slightly villous and sometimes covered with pseudo-membranes.

The sessile hyperplastic masses are more fleshy in consistency, generally pyriform, and a grayish-rose in color. They range in size from that of a millet seed to that of a grain of rice. It is sometimes difficult to establish a differentiation between the papillomatous excrescences and papillomata of non-inflammatory origin, even on microscopic examination. The histological appearance of these different forms of excrescences is described in detail. The different forms are manifestations of different stages of the inflammation, the excrescences from œdematous imbibition being the first stage due to erythema of the mucous membrane, and the papilliform excrescences and the polypoid masses, sessile and then pedunculated, representing the successive stages of the inflammation.

As these inflammatory new growths are so closely related to the bladder, prostate gland, and seminal vesicles, the symptoms may be due to irritation of any of those parts and are therefore not specific. Bladder, genital, or psychosexual symptoms may be the first to suggest the presence of such a chronic inflammation. The best treatment is the removal

of the new growths with the cautery, but even when this is done they occasionally recur.

AUDREY G. MORGAN, M.D.

Gautier, E. L., and Chevassu, M.: Four Different Forms of Urethral Polyps and Papillomata (Quatre formes différentes de polypes et de papillomes urétraux). *J. d'urol. méd. et chir.*, 1926, xxii, 314.

Four kinds of papillomata seen on urethroscopy of the posterior urethra are described: (1) the ordinary form with a single pedicle; (2) a form with multiple pedicles; (3) a subacute form with many different elements each having a pedicle; and (4) an acute diffuse papillomatosis invading the whole anterior urethra. A case of each type is reported and the urethroscopic appearance of each is shown by a colored plate.

Chevassu, who reported Gautier's cases, called attention to the fact that they were probably all of inflammatory origin. Case 3 presented interesting evidence of this, for, passing backward from the glans to the membranous part of the urethra, the papillomata gradually changed in character from the diffuse to the pedicled form. In Case 2 the papillomata resembled bladder papillomata. Chevassu does not approve of the name "multiple pedicled" selected by Gautier for though there were many papillomatous processes they seemed to rest on a common pedicle. He suggests the term "fringed papilloma." Because of its resemblance to a bladder papilloma, he thinks the growth was probably a urethral graft from a bladder tumor, but Gautier's report unfortunately does not tell anything regarding the condition of the vesical mucous membrane.

Ultraviolet rays had an excellent effect in one of these cases, and the passage of Béniqué sounds in another. This substantiates the theory of their inflammatory origin, but it is impossible to say why a subacute or chronic inflammation sometimes causes proliferation of the urethral mucous membrane. It is certain, however, that such proliferations in a case of urethral infection cause the infection to persist indefinitely, and in any chronic urethral suppuration that does not yield to the ordinary treatments a urethroscopic examination should be made. Gautier particularly likes Luys' apparatus, but for most cases Chevassu prefers the apparatus of MacCarthy.

AUDREY G. MORGAN, M.D.

Kretschmer, H. L., and Fister, G. M.: Plastic Induration of the Penis: A Report of Sixteen Cases. *J. Urol.*, 1926, xvi, 497.

The authors review the present-day knowledge of plastic induration of the penis and briefly discuss the course, pathology, and differential diagnosis of the condition. The prognosis is good in that the disease is usually self-limited, but poor in that it is not commonly cured. A few cases have been cured by fibrolysin injections, X-ray or radium irradiation, or operation, but on the whole, treatment is not satisfactory. In a small percentage of the cases there is a tendency toward spontaneous recovery.

Sixteen cases are reported and a bibliography is given.

JOHN G. CHEETHAM, M.D.

GENITAL ORGANS

Lazarus, J. A.: Deep Roentgen Therapy in Disease of the Prostate Gland. *J. Urol.*, 1927, xvii, 37.

Important factors producing urinary obstruction in adenoma of the prostate are congestion and œdema of the mucous membrane. The author has found that X-ray irradiation reduces the congestion and relieves the urinary symptoms but does not reduce the size of the prostatic tumor, decrease the amount of residual urine, or sterilize an infected prostatic focus.

MAURICE MELTZER, M.D.

Pugh, W. S.: Surgical Aspects of Chronic Prostatitis. *Med. J. & Rec.*, 1927, cxxv, 105.

The author advocates the surgical treatment of chronic prostatitis by the various forms of urethroscopic manipulation. A definite decision as to the extent of the pathological change is impossible without a cysto-urethroscopic examination. A very frequent cause of persistent prostatitis is the presence of polypoid masses. In order to obtain a cure, such masses must be eradicated. Occasionally prostatectomy is indicated in these cases.

J. SYDNEY RITTER, M.D.

Goldstein, A. E.: Bilateral Ligation of the Vas Deferens in Prostatectomy. *J. Urol.*, 1927, xvii, 25.

Goldstein advocates bilateral vasectomy in prostatectomy to reduce the complication of epididymitis to the minimum. Bilateral vasectomy is best performed in the scrotum. A section measuring from ½ to 1 cm. should be removed to prevent anastomosis. It is always advisable to do this before draining the bladder. In a series of cases so treated, epididymitis occurred in only 4 per cent. No effect of the procedure on sexual power was noted.

MAURICE MELTZER, M.D.

Marion, G.: An Intervesicoprostatic Diaphragm After Prostatectomy (Le diaphragme intervésicoprostatique après la prostatectomie). *J. d'urol. méd. et chir.*, 1926, xxii, 257.

Sometimes difficulty in urination develops again after a prostatectomy. A sound cannot be passed. The obstruction may be due to a diaphragm formed between the bladder and the bed of the prostate. When a periurethral adenoma protrudes into the bladder the summit of the protrusion is covered by very thin bladder wall which is much more easily torn than the normal bladder wall back of the adenoma. In the enucleation of the adenoma the break in the bladder wall should be made around the circumference of the adenoma, for if it is made at the vertex of the tumor the flap covering the

protruding part will be left and may form a diaphragm. Dysuria some months after a successful prostatectomy may be due to such a diaphragm or to an aberrant adenoma overlooked at operation. An aberrant adenoma, however, can be palpated through the rectum and will allow the passage of a sound into the bladder. Another lesion that may simulate a diaphragm is a constriction of the posterior part of the urethra just below the point at which the latter enters the bed of the prostate. In such a case, the constriction is lower than when a diaphragm is present.

The author has devised a cutting Béniqué sound for the removal of intervesicoprostatic diaphragms. During the introduction and withdrawal of the sound the blade is enclosed within it. After its introduction the blade is released by means of a wheel. Marion has operated successfully with this instrument in four cases. In some cases it may be necessary to open the bladder for the resection.

AUDREY G. MORGAN, M.D.

Thomas, B. A., and Birdsall, J. C.: Vasopuncture Versus Vasotomy Relative to Stricture Formation: An Experimental Study on Dogs. *J. Urol.*, 1926, xvi, 529.

Of eighteen vasotomies performed on dogs, 55 per cent were followed by occlusion of the vas, whereas of twenty vasopunctures only 5 per cent were followed by occlusion. A 5 or 10 per cent solution of collargol seemed to be a safe antiseptic for use in the vas providing there was no extravasation into the spermatic cord.

As the traumatism to the vas and the subsequent regurgitation and infiltration of the collargol into the spermatic cord produced occlusion in over 50 per cent of the operations reviewed, it is evident that vasotomy with the use of a 5 or 10 per cent solution of collargol should be performed with great caution. According to the findings of experiments, vasopuncture seems to be preferable to vasotomy.

JOHN G. CHEETHAM, M.D.

MISCELLANEOUS

Lowsley, O. S., and Butterfield, P. M.: Urological Conditions Among Children. *J. Urol.*, 1926, xvi, 415.

In an investigation of urological conditions in children every effort was made to arrive at a diagnosis before resorting to cystoscopy. All renal infections were studied bacteriologically and treated by various antiseptics. For cystoscopic examination of children Butterfield has devised a double catheterizing cystoscope. The authors believe that cystoscopic examination is as important in the cases of children as in those of adults. In a large percentage of the cases of children, however, the use of an anæsthetic is necessary.

Severe reactions, such as chills, fever, vomiting, and urethral pain, which are common in adults, do not occur in children.

The history is taken carefully in all cases and a complete examination is made by a pediatrician. A complete examination of the urine and an X-ray examination of the genito-urinary tract are made routinely. If the urine shows infection, alkalies are administered and the bladder is lavaged with acriflavine. If there is no response to this therapy, urotropine and acid sodium phosphate or hexylresorcinol is used. In some cases an autogenous vaccine is employed.

Local anæsthesia is indicated for older children, while nitrous oxide or ethylene is used for younger children. The youngest male subjected to a cystoscopic examination in the authors' clinic was 11 months old. In the making of a pyelogram in the case of a child under general anæsthesia, 5 c. cm. of a 20 per cent solution of sodium iodide is introduced.

The technique of sacral anæsthesia does not differ from that used for the adult except that the sacral hiatus is located somewhat higher than in the adult. Twenty-five cubic centimeters of a freshly prepared 1 per cent solution of novocaine is injected into the canal through the first, second, third, fourth, and fifth sacral foramina according to the technique of Labat.

In 100 cases of urological symptoms in children, the following diagnoses were made: incontinence of urine (enuresis) in thirty-seven; undescended testicle in eleven; stenosis of the meatus in five; hernia in five; hypospadias in two; spina bifida in three; congenital malformation of the posterior urethra in two; epispadias in one; pyogenic renal infection in nine; tuberculosis of the kidney in four; no pathological condition in seven; vaginitis in four; stricture of the ureter in three; perinephritic abscess in two; calculus in two; acute nephritis in one; lues in one; and venereal warts in one.

Seventy of the patients were males. The average age of the patients was 8 years. The youngest patient was 11 months old and the oldest, 16 years.

In the cases with enuresis all specimens of urine were found sterile. The patients were given an alkaline diuretic and a special diet, the head of the bed was raised, an afternoon nap was enforced, and water was withheld after 5 p.m. At 10 p.m. and 2 a.m. the child was awakened for urination.

The children who did not respond to this therapy were given acid preparations, atropin, and glandular products. Instillation of various solutions, irritating and non-irritating, was done. In a few cases 30 c. cm. of normal salt solution was injected into the sacral canal.

The results have been far from satisfactory. By the various procedures mentioned a cure has been obtained in only eight cases and improvement in seven. The authors believe that in every case which does not respond to treatment there is some underlying pathological condition and a careful endoscopic examination is necessary.

In discussing congenital anomalies the authors state that operative procedures should be avoided in the cases of children under 4 years of age as such

young children do not stand ether anæsthesia well and as their cooperation cannot be expected local anæsthesia is impossible. A circumcision should be done in the first few weeks of life. Meatotomy may be carried out under local anæsthesia, induced with 4 per cent cocaine. This is a very valuable procedure when there is a stenosis at the external meatus which interferes with drainage. Hydroceles usually occur in persons who have worn a truss or who had a trauma to the scrotum or its contents or a pathological process in the epididymis. Counter-irritation will usually effect a cure. In cases in which an excision of the hydrocele sac is necessary, the incision is made as for hernia. After evacuation of the sac, the excess is cut away and the edges are approximated behind the testicle.

In undescended testicle the high position of the testicle is caused by the shortness of the portion of the cord which contains the blood vessel, due to fascial bands surrounding the blood vessel. The vas deferens and the vessels themselves are long enough. A careful dissection should be made and these fascial bands separated from the vessels so that the testicle may be replaced in the scrotum and anchored there. The authors operated in this manner successfully in eleven cases.

In the two cases of hypospadias a preliminary suprapubic cystostomy was done. A quadrilateral incision was made on the ventral surface of the penis, beginning just anterior to the misplaced meatus and extending back to the base of the penis. A new elongated urethra was constructed around a catheter with the structures on the ventral surface of the penis. The glans penis was split entirely in two parts, the elongated urethra sutured at the apex of the glans penis, and the wound closed. The catheter was removed as soon as the repair was complete. The suprapubic fistula was kept open for ten days.

The authors report one case of spina bifida with urinary incontinence which they have operated upon successfully. Through a suprapubic incision a triangular piece was excised from the dilated vesical orifice and the wound sutured tightly over a No. 10 French catheter.

Congenital malformation of the posterior urethra is attributed by the authors to an anomaly of the wolffian and muellerian ducts. In the first of their two cases, that of an infant aged 3½ months, autopsy showed that the verumontanum, instead of disappearing by spreading out on the floor, continued down to the membranous urethra, where it divided into two portions and attached itself intimately to the entire urethral circumference. A very small slit-like opening was found on the floor of the urethra just to the left of the median line. The second case was that of an infant aged 14 months who evidently had considerable pain on attempting to void. The passage of a urethral bougie into the posterior urethra produced a tearing sensation. After several dilatations with the bougie the patient was cured.

In a case of complete epispadias with separation of the symphysis in a 6-year-old boy a finger could be inserted into the bladder without any resistance. Through a suprapubic cystotomy a V-shaped piece was resected from the neck of the bladder, a No. 10 catheter introduced, and suction drainage applied. Three months later the patient was able to hold his urine for two hours at a time and to tell when he wished to urinate. Four months after the first operation the urethra was repaired according to Young's technique. Subsequently, a small sinus developed on the dorsum of the penis, but this was repaired. At the present time, two years later, the patient is perfectly well.

Lowsley and Butterfield do not regard pyelitis as an entity. They believe that cases exhibiting local and systemic reactions have a pyelonephritis or pyonephrosis. Free drainage is essential in the treatment of all cases. Therefore every patient with chronic pyuria should be subjected to a complete examination of the renal pelvis, the ureter, the bladder, and the urethra. Of the authors' series of nine patients with kidney infection, seven were females. Six left the clinic before any treatment could be instituted; of the remaining three, one was apparently cured by hexylresorcinol and later suffered a relapse, and the two others with non-hæmolytic streptococcus infections were not benefited by alkali therapy, the administration of urotropin and hexylresorcinol, or vaccines. The authors' experience with hexylresorcinol has been rather disappointing.

While the authors have been able to find only forty cases of renal tuberculosis reported in the foreign literature and twelve in the American literature, they have seen four cases. They believe that tuberculosis of the kidney is not such a rare condition as was previously thought. Many of the chronic pyurias in infants and children are probably caused by tuberculosis. In two of their cases a secondary infection was found—a bacillus coli infection in one and an infection by the staphylococcus albus in the other.

Case 1 was that of a 13-year-old girl who complained of frequency of urination and marked pyuria. A right nephrectomy resulted in a cure.

Case 2 was that of a boy 14 years old who was admitted to the hospital with a diagnosis of acute appendicitis. His complaints were frequency of urination, dysuria, and nocturia. A right nephrectomy brought about a cure.

Case 3 was that of a girl 11 years of age who gave a history of frequency of urination, pain in the left flank, and marked pyuria. Guinea-pig inoculations were positive for tuberculosis. A cure followed removal of the left kidney.

Case 4 was that of a 6-year-old girl whose chief complaints were frequent urination and pyuria. Tubercle bacilli were found in the bladder urine. This patient was lost sight of.

In seven cases with a chief complaint of frequent and painful urination, no pathological changes could be demonstrated. Three cases of ureteral stricture,

which occurred in girls having sterile urine, were completely relieved by dilatation of the ureter. Perinephritic abscess is a common complication of tuberculosis of the kidney in children. In the authors' two cases, however, the condition followed an infection elsewhere in the body. Recovery was obtained in both after evacuation of the pus.

According to the literature, the incidence of urinary calculi in infants and children is not low. Pain and colic, hæmaturia, pyuria, frequency of urination, dysuria, nausea, and vomiting should lead to a thorough urological examination. In the case of a male infant 11 months old who was examined by the authors the chief complaints were abdominal pain and frequency of urination. Vesical calculi were found cystoscopically. The X-ray revealed calculi in the left kidney and ureter. Following suprapubic removal of the bladder calculi an uneventful recovery resulted. Unless symptoms are caused by the calculi in the ureter, Lowsley and Butterfield believe the infant should be kept under observation until it is at least 4 years old. In the case of a boy 10 years of age there were two attacks of pain in the right flank and along the course of the right ureter, accompanied by hæmaturia. The urine showed a large quantity of uric acid, but X-ray examination was negative. Permission for a cystoscopic examination was refused, but the authors believe the case was one of uric acid calculus.

A case of lues in a 12-year-old girl complaining of pain in the right kidney was cured by specific treatment.

In conclusion the authors state that children with a history of urological symptoms persisting for some time should be given a complete urological examination. ALTON OCHSNER, M.D.

Duvergey, Dax, and Ramarony: Vaccination in Gonorrhœa; Result in 202 Cases of Antigonococcus Vaccination (Contribution à l'étude de la vaccination dans la blenorragie; résultat de 202 cas de vaccination antigonococcique). *J. d'urol. méd. et chir.*, 1926, xxii, 322.

The authors have used the stock vaccine of the Pasteur Institute in 175 cases of gonorrhœa and an autovaccine in twenty-seven cases. In their dosage they followed the directions of the Pasteur Institute, beginning with ¼ c.cm., giving ½ c.cm. three days later, and then injecting 1 c.cm. every other day. They did not give any local treatment unless there were complications. In the majority of cases they administered only one series of injections.

They divide their cases into those of acute urethritis, those of subacute urethritis, those of chronic urethritis, and those of urethritis with local complications such as prostatitis, epididymitis, and cystitis, and those with general complications such as arthritis.

They treated twenty-nine cases of acute urethritis. In four, the condition was aggravated, in eighteen it remained unchanged, in five it was ameliorated, and in two it was cured. In sixty-three cases of subacute urethritis there was aggravation of the condition in five, no change in twenty-two, improvement in twenty, and a cure in sixteen. Of the fifty-eight cases of chronic urethritis treated with stock vaccine, twenty-six were unchanged; improvement resulted in fifteen, and a cure was obtained in seventeen. There were twenty-five cases of complicated urethritis. The eight cases of epididymitis among these did not seem to be affected at all. In ten cases of chronic prostatitis there was considerable improvement. In four cases of rheumatism the pain stopped after one or two series of injections; one case of arthritis of the knee with effusion and a tendency toward ankylosis was cured by three series of injections.

The autovaccines were used only in cases with a duration of months or years. Of twenty-seven cases of this type, ten showed no change, nine were benefited, and eight were cured.

Thirty-four patients had a moderate fever after the injections. In a few cases it was necessary to stop the treatment on account of high fever and vomiting. In some cases there was quite intense pain. In four, abscesses developed, but there were no bacteria in the pus.

While the method did not give any appreciable result in acute urethritis, it resulted in a cure in 28 per cent of the subacute cases and 26 per cent of the chronic cases. The autovaccine gave a cure in 31 per cent, and as it was used only in the oldest cases it seems to have been more effective than the stock vaccine.

Vaccination had no effect on epididymitis, but hastened the cure of chronic prostatitis when it was used in association with the usual treatment. Three cases of epididymitis and six cases of cystitis developed in the course of vaccine treatment without preceding lavage or instillation. A method which results in a cure in only 26 per cent of cases and does not prevent certain complications cannot be considered extraordinarily effective. However, while it is insufficient alone, it seems to be a valuable supplement to the local treatment of gonorrhœa as patients who received vaccine recovered more quickly later under irrigation treatment.

AUDREY G. MORGAN, M.D.

SURGERY OF THE BONES, JOINTS, MUSCLES, TENDONS

CONDITIONS OF THE BONES, JOINTS, MUSCLES, TENDONS, ETC.

Robertson, D. E.: Acute Hæmatogenous Osteomyelitis. *J. Bone & Joint Surg.*, 1927, ix, 8.

Rodet, in 1884, produced bone abscesses without trauma by the intravenous injection of staphylococcus aureus. Lexer found that large doses of an emulsion of living staphylococci injected intravenously into young rabbits caused death in twenty-four hours, while smaller doses produced abscesses in the viscera, muscles, bones, and joints. The abscesses in the bones were most commonly situated in the broad extremity of the diaphyses. The most common sites were the lower end of the femur and the upper end of the tibia and humerus.

Hobo cites Koch as demonstrating that the localization of infection from intravenous inoculation occurs most frequently in the epiphyses, the metaphyses, and the periosteal vascular region. Dummont produced typical osteomyelitis in young animals by the use of staphylococcus aureus from a furuncle. Two hours after the injection the organisms were found in veins of the metaphysis. He believed that they remained active and grew in the metaphysis and became the center of inflammation. Hobo believes that there is a marked slowing of the blood stream in the metaphysis due to the very small branching of the arteries. The medulla, on the other hand, is very rich in blood channels. He believes that the medulla is much richer also in phagocytic elements than the metaphysis. From these points the organisms emigrate into the metaphysis.

The experimental production of osteomyelitis seems possible only in young animals. Lexer states that older animals, like older persons, develop arthritis in the presence of blood infection.

In an attempt to verify some of the experimental work cited, the author conducted a series of experiments on young rabbits. Three of these experiments are described.

In one, 3 c.cm. of an emulsion of staphylococcus aureus made from a culture obtained from a case of acute osteomyelitis in a boy were injected into the vein of the ear. Two hours after the inoculation, sections of the long bones showed a most active phagocytosis throughout the epiphysis and the medulla. Very few cells containing organisms were found in the metaphysis.

In another experiment, an animal treated as in the first experiment was killed two weeks after the inoculation and the femur then incubated for thirty-six hours. Staphylococci in large clusters were found throughout the bone and were especially numerous in the epiphyses and the medulla and the metaphyses. Large groups were found also in the periosteum.

In the third experiment reported the animal was allowed to live for a week after the inoculation. Necropsy then revealed abscesses in the viscera, muscles, joints, and bones and sections of the long bones showed definite abscess formation in the epiphyses, metaphyses, and periosteum. The medulla, while injected, showed no tissue reaction or abscesses.

From these findings, the following conclusions are drawn:

1. Organisms introduced into the blood stream are deposited, among other places, in the long bones.
2. In bones, there is a very active phagocytosis except in the metaphysis.
3. The organisms produced inflammatory centers in the metaphysis independent of trauma.
4. It is impossible to produce a general infection of the medulla by the simple inoculation of organisms into the blood stream.
5. Trauma may determine a local infection.
6. Growing bones develop abscesses of the type of osteomyelitis. Adult bones do so but rarely. In the presence of a bacteriæmia in an adult, arthritis may develop.

The infection enters the blood stream through broken or diseased mucous membrane or skin. It was demonstrated experimentally that when small doses of an organism were given, the reaction was less violent and localization occurred.

From the experimental work that has been done it appears that trauma is not an essential factor in the production of the disease, but from the clinical standpoint there seems to be no doubt that trauma produces, or is closely related to, the initial bone lesion. The trauma is usually an injury to the epiphysis.

Acute hæmatogenous osteomyelitis is seen most frequently in children between the ages of 10 and 15 years and is more common in boys than in girls. There is usually a history of an injury to a joint or its region causing interference with function for a few hours or a day. An examination for lesions of the skin and mucous membranes should be made.

The first symptom of the bone infection is stiffness and pain at the site of the previous "sprain." Within twelve hours the pain becomes very severe and there is definite local tenderness over the metaphysis of the bone. The temperature and pulse show a considerable increase. During the second twelve hours all of the symptoms are increased and, in addition, there is a local œdema which later becomes reddened. Multiplicity of bone lesions occurs in over 75 per cent of the cases. A diagnosis of acute hæmatogenous osteomyelitis cannot be based on the blood count since even in very severe cases the leucocyte count may be low. In the first days the roentgenogram will not aid in the diagnosis.

This disease must not be confused with acute rheumatic fever. Multiplicity of lesions is common in both conditions. In rheumatism the pain is less constant and the history is different.

The diagnosis of an infection of the upper epiphyses of the femur must be made by aspiration of the hip joint.

The treatment is obviously surgical. Drainage of the lesion is indicated. In early cases an incision is made down to the periosteum over the affected part and drills are passed into the metaphysis parallel with, and close to, the epiphyses. If one of these drills taps the inflammatory center, it is essential to remove a small window from the cortex of the bone and leave the wound well open to establish free drainage. If the case is one that has gone on for days, drainage of the medulla may be necessary. Infection of the neck of the femur calls for drainage through the capsule and along the neck at its base. A careful watch must be kept for the appearance of lesions in other bones. These must be drained as soon as they are recognized.

NORMAN C. BULLOCK, M.D.

Chiasserini, A.: Chronic Abscess of Bone (L'ascesso cronico delle ossa). *Chir. d. organi di movimento*, 1926, xi, 1.

About 200 cases of chronic bone abscess have been reported. The author reports seven cases of his own. In three of his cases the abscess was preceded by acute osteomyelitis, in two by typhoid, in one by pyæmia, and in one by an undetermined febrile disease.

The time from the primary disease to the operation for the abscess ranged from three to thirty-one years.

In Gross' collection of 141 cases, the ages of the patients ranged from 21 to 27 years at the time of operation, but in 100 of them the symptoms had been noted twelve or more years before, showing that the disease began in childhood or adolescence.

There was a history of trauma in only one of the author's cases. In three, the pus yielded staphylococcus aureus, and in one, typhoid bacilli. In three, it was sterile. In two of the cases reported in the literature, colon bacilli were isolated.

Chronic bone abscess or Brodie's abscess is generally found in the metaphyseo-epiphyseal region of the long bones, particularly that of the tibia. In five of the author's cases it was in the tibia. It generally begins in the metaphysis and extends toward the epiphysis rather than the diaphysis. It involves the joint only rarely. The largest abscess in the author's cases was the size of a mandarin orange, but Thomson reports a case in which the abscess contained 500 c.cm. of pus. The abscess generally has a pyogenic limiting membrane. The bone for a short distance around it is usually increased in density, but the absence of sclerosis does not exclude an abscess of bone as some cases have been reported in which the surrounding bone was softened.

The relationship between the primary febrile disease and the secondary abscess is manifested by the localization of the latter or by the finding of the same bacteria in the two conditions. The first symptom of abscess is a vague intermittent rheumatoid pain which increases in intensity. The intermissions may last for months or years. If an intermission follows immobilization or specific treatment, the patient may erroneously believe himself cured. The pain is followed by local swelling which may also be intermittent. The disease is generally afebrile, but there may be attacks of fever. The leucocyte count is generally normal. The skin over the abscess may be normal or slightly red. The local temperature is generally increased, and there may be œdema. Palpation causes pain and may reveal a certain increase in the size of the bone. There are generally no joint symptoms. In some cases there is a lengthening of a centimeter or more.

Roentgen examination shows a local rarefaction with its longest diameter in the direction of the long axis of the bone. The rarefaction is so intense as to suggest a cavity in the bone. Its outlines are clearly defined, quite regular, and in many cases surrounded by a thin line of dense bone. Generally the end of the bone in which the abscess is located is enlarged. The diagnosis can generally be made from the roentgen findings.

The simplest treatment and the one which has been used in the majority of cases consists in opening the abscess with a gouge, emptying the pus, removing any limiting membrane that may be present, and tamponing. In order to shorten the drainage time, some surgeons have broken down the lateral walls of the abscess to decrease its depth and laid pedunculated grafts of periosteum and skin over the inclined plane formed in this way. This shortens the time required for treatment even if the flaps retract, but it sometimes causes considerable local deformity. When there is not much suppuration it may be possible to close the soft tissues without drainage. In such cases the abscess cavity is generally filled with Beck's or Mosetig's paste, a mixture of hard paraffin and wax, or grafts of fat or muscle. It is advisable to supplement the surgical treatment with the use of autogenous vaccines.

AUDREY G. MORGAN, M.D.

Stone, C. A.: Ossifying Hæmatoma. *J. Am. M. Ass.*, 1926, lxxxvii, 1885.

STONE reports six cases of ossifying hæmatoma. He believed that these tumors were produced by a blow sustained during muscular relaxation which allowed the force of the blow to be delivered almost entirely against the bone. To test this theory he carried out a series of experiments on dogs. In these experiments a blow was struck across the anterior surface of the femur on one side during the struggling of the animal before complete anæsthesia, when the thigh muscles were tense, and against the other femur after relaxation was complete. In no case was an ossified hæmatoma produced.

Of the six cases reported, all followed a single trauma sustained during athletic competition. A hæmatoma was formed and later grew smaller and ossified. The tumors consisted of bone entirely covered with periosteum. In every case, ossification took place within two months. In one case there was a tumor in each femur, a fact suggesting an inherent tendency toward such formations.

FREDERICK A. JOSTES, M.D.

Goforth, J. L.: Giant Cell Tumor of Bone. *Arch. Surg.*, 1926, xiii, 846.

The benign giant cell tumor, the most common of the central bone lesions, occurs characteristically in the epiphyses of the long bones of young adults. The initial symptoms are swelling and pain. The condition progresses slowly. After from three to eighteen months the chief complaint is a disturbance of function. The roentgenograms show circumscribed, diffusely mottled, rarified areas produced by the bone absorption of the expanding growth.

While we are familiar with the clinical, roentgenological, pathological, and histological characteristics of giant cell tumors, our knowledge of their true nature, behavior, and course remains far from complete and our interpretation of their structure is quite unsatisfactory. Barrie regarded these tumors as local, chronic, inflammatory processes, while others consider them true neoplasms. The giant cells have been believed to be of bone, marrow, foreign body, or endothelial origin, but some investigators consider them osteoclasts. Bloodgood, Codman, Meyerding, and others regard the giant cell tumor as benign, but there is evidence that they may invade and destroy nearby tissues and in rare cases may even form metastases.

In the author's opinion, giant cell tumors should be classified as true neoplasms. They constitute a series. Those at the lower end of the scale possess relatively adult fibrous stromas and are essentially benign. Under the stimulus of inadequate or improper treatment they may recur locally, those at the upper end of the scale being especially liable to do so. Such recurrences are usually more virulent than the primary growth. They are potentially malignant, and as the result of repeated or improper treatment undergo malignant transformation and metastasize.

DANIEL H. LEVINTHAL, M.D.

Jepson, P. N.: Ischæmic Contracture. *Ann. Surg.*, 1926, lxxxiv, 785.

Ischæmic contracture follows an injury to the extremities, usually the upper extremity. Fixation by some method or by tight bandaging causes severe pressure on the injured structures which is followed in a short time by swelling, blueness of the extremity, paræsthesia, and more or less pain. If the arm has been injured this is followed by severe contraction of the wrist and fingers and finally by the claw hand deformity. There may be disturbances in sensation in areas supplied by the ulnar nerve and sometimes in the area supplied by the median or radial nerves. Volkmann believed that the muscular tissue is deprived of arterial blood and in consequence the muscle perishes from want of oxygen.

The credit of calling attention to ischæmic contracture and establishing it as a true entity belongs to Leser who investigated the condition experimentally and gave a comprehensive and detailed account of his findings. Thomas, Bernhardt, Kohner, von Frey, and others believed that the paralysis follows the use of an elastic bandage which results in flaccid paralysis and contracture of the muscles due to injury to the nerves at the time of the accident or subsequently. Some writers have maintained that the contracture is due to the scar tissue resulting from pressure sores, but this is disproved by cases in which the typical deformity of the Volkmann-Leser contraction has developed without pressure sores.

So far as Jepson was able to determine, the mechanism of ischæmic contracture as seen in man has never before been reproduced in an animal. For this reason the experiments carried out at the Institute of Experimental Medicine of the Mayo Foundation are reported.

Dogs weighing approximately 12 kgm. were used in all of the experiments. The lesion of ischæmic paralysis as seen in man was reproduced in the animals by bandaging one extremity and preventing the return of the venous blood. In an attempt to prevent the development of the deformity it was found that if drainage was instituted within a few hours after the procedures which caused the lesion, contracture did not occur or was very slight. The results of these experiments seem to indicate that the contracture deformity is due to a combination of factors, the most important of which are impairment of the venous flow, extravasation of blood and serum, and swelling of the tissues with consequent pressure on the blood vessels and nerves in the affected area.

It can be understood that no one factor is responsible for the production of the typical deformity seen in a case of the Volkmann-Leser ischæmic contracture. It seems that the deformity in man is usually produced somewhat as follows: First, there is a fracture in the region of the elbow joint or of the humerus or bones of the forearm, an injury to the soft parts, or a fracture of a clavicle. Splints, casts, or bandages may or may not be applied. When splints are used, pressure sores often develop, usually over the flexor muscles and scar tissue may form. But pressure sores are not required to bring about the deformity. The tissues are bruised by the trauma, and extravasation of blood and serum follows. The tension may be so great as to cause cyanosis of the entire forearm. This intrinsic pressure causes local myositis and pressure on the nerves (usually the median and ulnar) and upon the blood vessels. Flaccid paralysis develops, followed by swelling in the muscles. Almost immediately, contraction of the flexor muscles begins, and the main-en-griffe deformity originally described by Volkmann results.

As the process goes on, owing to the diminished blood supply, the flexor muscles begin to atrophy and the tendons become matted together. When the wrist is hyperflexed the fingers can be straightened. If the intrinsic pressure is relieved within a short time after the formation of the hæmatoma, the deformity may be corrected.

Adie, W. J., and Bankart, A. S. B.: Spastic Paralysis. *Brit. M. J.*, 1926, ii, 1208, 1211.

ADIE limits his remarks to the condition resulting from diseases of the upper neurones of the pyramidal system in children.

Little's disease, the most common form of cerebral diplegia, is characterized by a preponderance of rigidity over paralysis. The essential anatomical lesion is a primary degeneration of cerebral neurones. According to many, the most important etiological factor is injury to the brain at birth. Precipitate and protracted labors are associated with cerebral injury. In examinations of the brains of hundreds of children who died during the first seven months of life, Schwartz of Frankfort found gross pathological changes due to birth injury in 65 per cent. Diplegia without gross macroscopical change in the appearance of the brain is extremely rare.

During the war, Adie noted that gunshot wounds of the vertex produced a transitory clinical picture of Little's disease.

Familial diplegia is progressive until death, whereas the ordinary non-familial type is not.

The non-familial type is helped very considerably by operative measures if there is no gross mental defect. Adie calls attention to the tendency to overestimate the severity of mental impairment in diplegic children. Athetoid and choreiform movements, when at all marked, are contra-indications to operative measures.

Adie discusses at length familial amaurotic idiocy, which is characterized by progressive mental impairment, spastic paralysis, and loss of vision, and a cherry-red spot at the macula and ends in death before the second year of life. He discusses also various other more or less obscure conditions such as Merzbacher-Pelizaeus disease.

In speaking of decerebrate rigidity, he cites the work of Rademaker who proved that rigidity is absent so long as the red nucleus is intact. He dismisses the subject of the rôle played by the sympathetic in muscle tone with the statement that there is no evidence to substantiate this theory.

BANKART states that spastic paralysis is not a disease but a physiological state which closely resembles, if it is not identical with, decerebrate rigidity. The latter represents the removal of the inhibitory and controlling influence of the cerebral cortex from the parts of the central nervous system below. Under such circumstances, the latter enter into a state of abnormal reflex activity and the end-result is exaggeration of the postural reflex, paralysis of reciprocal innervation causing failure of the muscles on one side of a joint to relax when those on the opposite side contract, and loss or impairment of the power of voluntary movement.

In Bankart's opinion, the best method for the relief of spastic contracture yet devised is Stoeffel's operation. Foerster's posterior root section and the operation of Royle and Hunter, sympathetic ramisectomy, are inadequate.

FREDERICK A. JOSTES, M.D.

Kulenkampff, D.: A Celluloid Protection for the Finger, and a Contribution on the Treatment of Lacerated Extensor Tendons of the Fingers (Der Celluidfingerling; zugleich ein Beitrag zur Behandlung des Abrisses der Fingerstrecksehne). *Muenchen. med. Wchnschr.*, 1926, lxxiii, 1485.

The author describes a method of treating separation of the extensor tendons of the fingers from the points of attachment which he has used with good results on himself.

With the use of a finger from a Mikulicz glove and an 8 per cent skin-colored solution of celluloid, he makes a hard cap for the finger in the position of extension. He covers an uninjured finger with salve, inserts it in the glove finger, and then dips it several times in the celluloid solution. When, on drying, the glove finger becomes stiff, it is withdrawn and given another coat of celluloid on the inside. To keep it from shrinking, it is then dried on a Hegar dilator. It is best to choose a glove finger of large size.

The cast so made can be washed and sterilized and provides complete fixation of the terminal phalanges when the extensor tendons are torn off.

The author describes also the preparation of a protective cast to be used after the loss of a fingernail or when a fissure has formed in the end of a finger. BODE (Z).

Balensweig, I.: Unusual Vertebral Injuries: Report of Cases. *Arch. Surg.*, 1927, xiv, 29.

In cases diagnosed as back strain a fracture or fracture dislocation of the spine is often present. A clinical examination made before the development of an anxiety neurosis and supplemented by good roentgenograms should establish the diagnosis in most cases.

Fractures of the spine are usually the result of indirect force and most commonly involve a single vertebral body. They occur most frequently in the dorsolumbar segment extending from the eleventh dorsal to the third lumbar level. The first lumbar vertebra is the one most often involved. Fracture dislocations occur more frequently in the upper cervical and lower lumbar regions where the mobility is greatest.

At the site of the lesion there is pain which is aggravated by movement of the spine, a blow on the head, or jumping on the heels. Pain is referred along the nerves from the level of the injury, and there is weakness of the trunk or extremities.

Physical examination may reveal an awkward gait with the body tilted; a gibbus or flattening at the

site of the lesion; lateral deviation of the spine, occasionally with rotation; restriction of motion; local tenderness; and muscular rigidity. The reflexes are exaggerated or lost. Muscular paralysis and localizing sensory changes are usually present. Neurological findings are frequently absent or late in appearing.

Roentgenograms in two projections should be taken. The lateral view is most important in the diagnosis.

The author reports eighteen cases and illustrates them by fourteen plates. These emphasize the value of conservative treatment, particularly in young persons, and the excellent results obtained by grafting or fusing the spine in selected cases.

W. P. Blount, M.D.

Mathieu, P.: The Treatment of the Sequelæ of Coxalgia (Traitement des séquelles de la coxalgie). *Rev. d'orthop.*, 1926, xxxiii, 581.

Coxalgia may terminate in: (1) complete ankylosis, which is favorable if the limb is straight, unfavorable if it is in a vicious position; (2) incomplete ankylosis with extensive destruction of bone and conservation of limited mobility; (3) intracotyloid pseudarthrosis with very extensive mobility of the femur on the pelvis; (4) pathological luxations of the femur which may end in ankyloses, particularly in subluxations or extra cotyloid pseudarthrosis and instability of the hip in complete luxation; or (5) double coxalgia in which a combination of lesions in the two hips causes a serious infirmity.

In complete ankylosis in vicious position a high osteotomy of the femur gives excellent results. In incomplete ankylosis, osteotomy may cause recurrence in a vicious position unless a careful technique is used. This sequela can be avoided more surely by bringing about ankylosis of the hip by arthrodesis.

Ankylosis of the hip also remedies the complication of intracotyloid pseudarthrosis with great mobility of the joint. Among the most important symptoms of this complication is pain of mechanical origin. The author prefers extra-articular to intra-articular arthrodesis and thinks it may be substituted with advantage for the long-continued wearing of an orthopedic appliance.

In extracotyloid pseudarthrosis with great mobility of the hip the decision as to the treatment indicated is difficult. Fixation of the femur to the pelvis by an operation similar to arthrodesis is justified only by pain. In cases of flail hip which is not painful the surgical establishment of a good pelvic support for the femur seems to be the best solution of the problem.

In double coxalgia, ankylosis in a straight position on one side with mobility on the other is a combination more favorable functionally than a double straight ankylosis. However, there is a great deal of uncertainty in all of the operations proposed for attaining articular or para-articular mobility in the coxalgic hip.

In the discussion of this report, Rendu reviewed the late results in six cases of intra-articular arthrodesis for coxalgia. In one, he obtained an ankylosis which appeared to be bony; in three, complete ankylosis without bony union; and in two, an incomplete ankylosis with movement of about 5 degrees. He regards atypical operations as best. The object should be to coapt the largest intra-articular and extra-articular surfaces of healthy bone by the best method possible.

Lance has practiced osteotomy for vicious position of the femur after coxalgia in sixteen cases. Five of the patients were children. In thirteen cases he performed a low subtrochanteric osteotomy; in one case, the Lorenz Y-shaped osteotomy; and in two cases the Schanz osteotomy with support on the ischium. None of the patients showed complete ankylosis under general anæsthesia. Lance stated that if osteotomy were performed only for complete ankylosis it would hardly ever be performed. He has seen eleven of his patients since the operation; none of them has shown a recurrence of the deviation. He does not regard the persistence of limited mobility of the joint as a contra-indication to osteotomy. He prefers the low osteotomy to the Y-shaped osteotomy of Lorenz; a point of support on the pelvis is also good and there is less loss of length. He believes that the indications for extra-articular arthrodesis are very limited.

Nové-Josserand stated that some of the serious forms of incomplete ankylosis are due to persistence of the inflammation rather than to poor static conditions of the joint. Formerly, resection was practised in these cases, but arthrodesis is capable of curing some of them with less loss. There are three conditions under which artificial consolidation of the coxalgic hip is necessary: (1) coxalgia healed with incomplete ankylosis and recurrent vicious attitude; (2) coxalgia healed with insufficient support as a result of destruction of the head and the establishment of an intracotyloid pseudarthrosis or a pathological luxation; and (3) torpid coxalgia which does not heal in spite of long-continued treatment. There are three methods of bringing about this consolidation: intra-articular arthrodesis, para-articular arthrodesis, and osteotomy with a support.

The results of grafting seem to be uncertain. In Nové-Josserand's opinion, Mathieu is a little severe in his judgment of intra-articular arthrodesis when he maintains that it is dangerous and may reactivate the tuberculosis. Nové-Josserand believes the first objection is not true and the second is true to some extent of all operations in tuberculosis. Intra-articular arthrodesis has the great advantage of exposing the lesions to view and making it possible to curette a focus of fungosities, remove a sequestrum, or cleanse a residual abscess cavity. That is why this operation seems to be indicated particularly in cases in which healing of the coxalgia is not certain.

Para-articular arthrodesis by a trochanteric bolt is very interesting but has not yet stood the test of

time. It is questionable whether the contact of surfaces so small as those of the trochanter and iliac bone will give a firm consolidation. This operation seems to be indicated most definitely in intra-cotyloid pseudarthroses in which, as a result of the disappearance of the head and a part of the neck, the trochanter is almost in contact with the rim of the acetabulum and can be easily adapted to it. Each of the three methods has its indications in different anatomical forms of the sequelæ of coxalgia.

TRÈVES agreed with Mathieu that adduction is the deviation most difficult to avoid. Flexion is almost as frequent. Inward rotation is less constant and less harmful. Therefore, during the entire evolution of the lesion, Trèves immobilizes in extension-abduction and slight inward rotation. He does not regard ankylosis as the ideal form of healing. Restoration to normal with preservation of at least a certain degree of mobility of the joint with a correct position of the limb is being accomplished more and more frequently by heliotherapy combined with plaster immobilization. To obtain this result, however, ambulant apparatus must be worn for a long time. With this treatment, vicious positions are becoming more unusual. When they occur, the best treatment in the great majority of cases is a high linear subtrochanteric osteotomy. Trèves does not approve of cuneiform osteotomy with or without osteosynthesis; these are useless and increase shortening. He has abandoned oblique osteotomy also. He believes that plaster immobilization for from forty-five to fifty days after operation is sufficient. He reserves ankylosing operations for cases with a protracted course and those in which high osteotomy followed by correction in abduction and slight inward rotation have failed.

TAVERNIER stated that in his opinion Mathieu has too much distrust of intra-articular operations. He has noted that this attitude is general on the part of Paris surgeons. Ankylosis is no more difficult to obtain by an intra-articular operation than by an extra-articular operation.

ROCHER called attention to the fact that not every coxalgic hip that is ankylosed is defective functionally. To prevent progressive adduction, it is generally necessary for the patient to wear an apparatus for a long time. Ankylosing operations by the extra-articular method render the wearing an apparatus for a long time unnecessary. Rocher regards Mathieu's method as one of the best.

DUPAN thinks that the aim of treatment in coxalgia should not be ankylosis in all cases. Healing with perfect restoration of function has been brought about by heliotherapy and immobilizing plaster extension during the painful period. However, it is very difficult to tell when a coxalgia is cured.

SORREL agreed in general with the conclusions of Mathieu, but he thinks that ankylosis is not the only desirable termination of coxalgia, at least not in children. Quite frequently some movement of the hip persists after a benign coxalgia which has been properly treated. This movement should be respected; ankylosing operations are justifiable only in cases in which walking is difficult, and these are rare. AUDREY G. MORGAN, M.D.

Lasserre, C., and Mouchet, A.: A Pseudo-Cystic Giant-Cell Tumor of the Femur in a Child 32 Months of Age; Curettage Followed by Filling of the Cavity with an Osteoperiosteal Graft from the Mother; Consolidation; Late Result (Tumeur pseudo-kystique à myéloplaxes du fémur chez un enfant de trente-deux mois; évidement suivi de comblement per greffons ostéopériostiques homoplastiques d'origine maternelle; consolidation; résultat éloigné). *Bull. et mém. Soc. nat. de chir.*, 1926, lii, 886.

The child whose case is reported was first seen by Lasserre on November 8, 1924. A month previously he had fallen and was unable to rise because of intense pain at the upper portion of the right thigh. A physician applied a splint and advised a roentgen examination. He interpreted the roentgenogram as showing fracture and osteitis of the femur, and immobilized the limb in plaster.

Lasserre removed the plaster. The child did not feel any pain when his hip was mobilized. The hip appeared normal and the fracture appeared to be consolidated, but the movements of the hip joint were limited. Roentgen examination showed a dappled clear area with its upper pole 2 cm. below the joint cartilage and its lower pole 3 cm. lower. This was surrounded by a shell denser than the surrounding bone. At its two thinnest points the bone cortex which constituted the shell was fractured. Lasserre made a diagnosis of bone cyst with pathological fracture, but was doubtful regarding it, as a sister of the patient had tuberculosis of the calcaneum and he had recently had a case of tuberculous cyst of the neck of the femur which was verified by operation.

Considering the age of the patient and the fact that bone cysts sometimes disappear under immobilization, he immobilized the leg. When the apparatus was removed on February 8, 1925, the upper end of the femur in the region of the greater trochanter was found to be swollen. There was an elongation of the right leg of 2 cm. Movements of the hip joint were possible and not painful. Consolidation seemed to have occurred.

On February 20, the infant, who was extremely active, climbed on a chair and fell, sustaining a subtrochanteric fracture of the right femur. Roentgen examination the next day showed the picture of a cyst resembling that described before but larger. At operation, the defect was filled with an osteoperiosteal graft. The graft was taken from the mother's tibia as it did not seem possible to obtain enough bone from the tibia of a child so young. The histological picture was that of a giant-cell tumor.

Roentgen examination made on May 14, 1926, showed consolidation with an elongation of the

limb of 2½ cm. The hip movements were normal. The spotted appearance of the diaphysis had given place to bone condensation.

Mouchet, who presented Lasserre's report to the Surgical Society, concluded from a study of the roentgenograms that the case was one of fibrous osteitis. There were only a few groups of giant cells at one point. Fibrous osteitis is rare at this age; as a rule it occurs after the sixth year, particularly in the period of adolescence. The two diseases are closely related, and Mouchet regards it as probable that they are only two stages of the same condition. AUDREY G. MORGAN, M.D.

Bernstein, M. A., and Arens, R. A.: Diagnostic Inflation of the Knee Joint: A Clinical Radiological Study. *Radiology*, 1926, vii, 500.

The authors discuss derangements of the knee joint which under ordinary circumstances present negative findings in the roentgenogram. Soft tissue structures do not readily cast a shadow unless they have undergone considerable change or some medium is introduced to outline them. Liquids injected into a joint for diagnostic purposes are too irritating, often leading to the formation of adhesions, and are absorbed too slowly. Gaseous substances are better. Oxygen or carbon dioxide should be used. The authors employ carbon dioxide because it is very readily absorbed and produces very little irritation.

The anatomy of the knee joint is reviewed with special reference to the spaces which can be inflated. The normal appearance of these spaces when they are inflated is shown by roentgenograms. The authors' technique for the inflation is described in detail. The parts rendered visible by this method are the synovial membrane, fat pads, and semilunar cartilages. The conditions concerning which information may be obtained are: tears of the ligamentous structures of the joint, displacements and tears of the cartilages, and chronic synovitis.

The article includes roentgenograms of various lesions with legends describing the findings. The procedure has had no untoward results. The authors have found it a valuable aid in the differential diagnosis of knee-joint derangements and frequently have obtained evidence from it which justified arthrotomy. ADOLPH HARTUNG, M.D.

SURGERY OF THE BONES, JOINTS, MUSCLES, TENDONS, ETC.

Lavalle, R., and Ombrédanne, L.: The Treatment of All Forms of Tuberculous Osteo-Arthritis by Bone Grafts (Traitement par les greffes osseuses de toutes les ostéo-arthrites tuberculeuses). *Bull. et mém Soc. nat. de chir.*, 1926, lii, 955.

In 1923 Lavalle reported a method of bone grafting for the treatment of tuberculosis of the knee. He has now extended the method to the treatment not only of tuberculosis of all bones and joints, but also of tuberculosis of the lungs. In twenty-one cases he has passed a bone graft through the lung immediately below a cavity. His method is based on the theory that there is a venous congestion at a tuberculous focus because the vessels are compressed, and while the arterioles can overcome the pressure sufficiently to bring blood in, the veins cannot overcome it sufficiently to carry the blood away. When a tuberculous epiphysis is sectioned, a large quantity of black, thick blood is discharged; this exercises pressure on the bone tissue. The pressure to which the bone is subjected and the poor oxygenation resulting from dilatation of the veins furthers the progress of the tuberculosis. The object of the described method is to restore circulatory rhythm and carry off the excess of fluid. Lavalle introduces two intra-osseous grafts, one above and one below the joint and connects them at the ends by a subcutaneous bone graft to be removed later. The grafts drain the dilated veins and relieve the pressure. They carry off blood through the capillaries which rapidly penetrate them.

In the treatment of Pott's disease a longitudinal subcutaneous graft is made running up and down the affected part of the spinal column. Grafts are run obliquely inward and downward from this, penetrating the body of one vertebra obliquely and passing through the intervertebral disk and into the body of the vertebra next below.

Twenty clinical cases are reported, the reports being illustrated with photographs of the patients and roentgenograms of the joints treated. Lavalle claims to cure all forms of tuberculous osteo-arthritis, whether with or without fistulæ and regardless of the age of the patient, within one month, by using the proper technique for each joint.

Ombrédanne, who presented this report to the Surgical Society, reported four cases of his own which were operated upon by Lavalle's method and several others which were operated upon by similar methods. He found that the operation quickly relieves the pain, brings about recalcification of the epiphysis and also of the metaphysis when the latter is traversed, and helps to restore joint function, but he is inclined to think that Lavalle claims too much for it. While the patients treated by Lavalle recovered with free movement, Ombrédanne's patients recovered with ankylosis and his results were not obtained so quickly as those reported by Lavalle. Ombrédanne suggests the possibility of exciting an acute attack of tuberculosis by a central graft and of the interference of such a graft with the later growth of the bone in children. However, he thinks the method a very important one and recommends further tests of it. AUDREY G. MORGAN, M.D.

Johansson, S.: On the Treatment of the Ischæmic Contraction of Muscles. *Acta chirurg. Scand.*, 1926, lxi, 188.

The author reports three advanced cases of ischæmic muscular contractions which were cured by operative liberation of all of the flexor muscles and plastic elongation of all of the flexor tendons.

This excellent article on a very important subject should be widely read. Johansson discusses various methods of treatment none of which has given such uniformly good results as the one herein described.

Pieri, G.: Plastic Reconstruction of the Thumb (Contributo alla ricostruzione del pollice). *Chir. d. organi di movimento*, 1926, xi, 89.

Pieri reports three cases of traumatic lesions of the thumb and one of congenital malformation of the hand. In the first three he made a curvilinear incision beginning at the tubercle of the scaphoid and passing around the thenar eminence. Another incision was begun at the angle between the base of the thumb and the adjacent metacarpal and directed toward the apex of the second metacarpal, running around it in a racket shape to remove the exuberant skin. A third incision was made on the back of the hand running parallel with the first metacarpal and at a little distance from it and continuing distally with the first incision. These three incisions converged toward the base of the thumb at the angle of the first interdigital space.

The first metacarpal was then disarticulated and the adductor pollicis resected. This did no harm as the prehensile function of the thumb depends almost wholly upon the opponens and the flexors. The skin flap from the thenar eminence was wrapped around the first metacarpal, which was used as the basal phalanx of the new thumb, and the skin flap from the dorsal surface of the first interdigital space was brought around to the thumb and used to cover the third metacarpal. The anatomical and functional results of the operations were excellent. The new thumb had a good prehensile power; even in the case in which all of the fingers had been lost, small objects could be held.

In the case of congenital malformation, all of the fingers and the thumb were fused together. At operation, the thumb bone was separated from the others by a longitudinal incision through the soft parts and pulled away from the other fingers. The two proximal phalanges of the second finger and the distal half of the second metacarpal were removed. A skin flap was cut on the back of the hand between the first and second fingers, dissected free from the underlying tissues, brought around to cover the interdigital space between the thumb and the rest of the hand, and fixed with interrupted silk sutures. The margins of the gap left by the removal of the skin flap were sutured together. This was easy on account of the removal of the bones of the second finger. The thumb has good opposition and prehension.

AUDREY G. MORGAN, M.D.

Dega: Plastic Operation on the Thumb by Wierzejewski's Method and Its Late Results (La plastique du pouce d'après la méthode de Wierzejewski et ses résultats éloignés). *Rev. d'orthop.*, 1926, xxxiii, 497.

Wierzekewski has been performing his plastic operation on the thumb since 1916. A new thumb is formed from the first metacarpal of the same hand. Four illustrative cases are reported briefly. The results are permanent and the patient has excellent use of his hand.

One of the cases reported was that of an organist and violinist. Since the operation this patient has been able to carry on his work. No trophoneurotic ulcers develop as they frequently do after the transplantation of toes or free grafts. The technique is simple and the method is less mutilating than others as neither the toe, finger, or graft is sacrificed and there is less risk of failure than in transplantation.

AUDREY G. MORGAN, M.D.

FRACTURES AND DISLOCATIONS

Leriche, R.: The Treatment of Compound Fractures (Du traitement des fractures compliquées). *Bull. et mém. Soc. nat. de chir.*, 1926, lii, 1105.

In the opinion of the author, primary suture at the level of a compound fracture should not be done. Statistics cited against this view are misleading, since usually the type of fracture is not stated and many fractures classed as compound are not compound. Moreover, the statistics do not give the number of amputations performed for fracture during the same period, and this must be taken into consideration. If the wound is left open, osteosynthesis need not be rejected as too dangerous, and may be indicated when, for instance, the fracture is irreducible or cannot be maintained in reduction or when there is an interposed fragment, or the fracture is juxta-articular. However, this is not the method of choice as it may lead to delayed union, pseudarthrosis, exuberant callus, or fistulæ.

The best treatment is a three-stage procedure: (1) cleansing, (2) cutaneous suture; and (3) osteosynthesis or grafting. This method also has several disadvantages. In the leg, retraction of the skin may render suture impossible after several days. Autoplasty may be done or a dermo-epidermic graft applied to save time, or the wound may be allowed to heal by secondary cicatrization. This may prevent osteosynthesis, but the latter often proves to be unnecessary.

Between 1919 and 1925, the author treated twenty-one compound fractures, in three of which primary osteosynthesis was done because of irreducibility. In only four was secondary osteosynthesis necessary. There were no deaths. The results in cases treated routinely by primary osteosynthesis are far less satisfactory.

LEO M. ZIMMERMAN, M.D.

Rieger: The Degree of Working Capacity After Fractures (Ueber den Grad der wiedererlangten Arbeitsfachigkeit nach Frakturen). *Arch. f. orthop. u. Unfall-Chir.*, 1926, xxiv, 209.

The author reviewed 1,400 accident cases to determine the capacity for work after fractures. The cases were studied with regard to the patient's age, the duration of incapacity, and the nature of the

injury. In general, the results are considered "not especially good." Return to normal was seldom prompt enough to prevent the necessity for financial aid. The quickest restoration occurred in cases of fractures of the radius and ribs. The majority of the patients recovered their previous working capacity, but this usually required some time during which financial aid was required. All tended to exaggerate their injury. Most of them were agricultural workers.

HACKENBROCH (Z).

ORTHOPEDICS IN GENERAL

Lowman, C. L.: The Underwater Gymnasium as an Adjunct to Orthopedic Surgery. *J. Bone & Joint Surg.*, 1927, ix, 119.

The underwater gymnasium is employed by Lowman in the treatment of various types of orthopedic conditions such as old and recent poliomyelitis, cerebral palsy, congenital hip conditions, postural defects, etc. A pool 3 ft. deep containing 2½ ft. of water is divided into two sections, one for salt water and the other for fresh water, the temperature of which ranges between 88 and 91 degrees F. The children are placed on various types of apparatus, such as submerged plinths, English surf boats, etc., and instructed in active and passive exercises. They are supported in the water also by the physiotherapy workers and given exercises for muscle re-education.

In ten cases of recent poliomyelitis this method was followed by more rapid and satisfactory improvement than any method used previously. It should be used, not as a substitute for muscle training in the gymnasium or in bed, but as an adjunct to the latter. In old poliomyelitis the pool treatment tends to tone up the body and assists in gymnasium work. The psychological effect is very marked, as the patients feel they are participating in active sport. The treatment of congenital and other hip conditions is greatly facilitated by the pool method.

RUDOLPH S. REICH, M.D.

SURGERY OF THE BLOOD AND LYMPH SYSTEMS

BLOOD VESSELS

Winslow, N.: Extracranial Aneurism of the Internal Carotid Artery: History and Analysis of the Cases Registered up to August 1, 1925. *Arch. Surg.*, 1926, xiii, 689.

Winslow reviews 106 cases of extracranial aneurism of the internal carotid artery—forty-two spontaneous, eighteen erosive, twenty-six traumatic, nineteen arteriovenous, and one unclassified. The condition has sometimes been mistaken for peritonsillar abscess and lancing has been done with a consequent fatal hæmorrhage. Prompt diagnosis and correct surgical treatment will save life in most cases, but in the past many patients have died under dilatory or incorrect treatment.

Of the 106 cases reviewed, seventy were operated upon, thirty-five were treated conservatively, and one was found at autopsy. In the seventy cases treated surgically, a cure resulted in 65.71 per cent, improvement in 2.86 per cent, no improvement in 1.43 per cent, and death in 30 per cent. In the thirty-five treated conservatively, a cure resulted in 8.5 per cent, no improvement in 17.14 per cent, and death in 71.43 per cent; in 2.86 per cent the outcome is uncertain.

Operation is the surest and quickest method of relieving the condition permanently.

As a rule the symptoms are frank. On inspection of the throat there is seen a bulging in the lateral pharyngeal wall. The swelling may be circumscribed or diffuse. To the touch it is soft and elastic, and pulsates throughout its entire extent. Externally there may be no evidence of the condition or there may be bogginess and a distinct lump behind the angle of the jaw. With the stethoscope placed over the swelling, a bruit may be heard. Both murmur and pulsation cease when the common carotid artery is compressed against the vertebral column. The symptoms include dysphagia, dyspnœa, hoarseness, deviation of the tongue toward the affected side, a roaring in the ears, mild cerebral symptoms, and hemicrania. Diagnostic puncture is warranted only if prompt carotid ligation can be done in case of rupture through the path of the needle.

The treatment of choice is ligation of the internal carotid artery proximal to the aneurism or ligation of both the common and external arteries and any branches of the latter arising between the site of the ligation and the bifurcation. Aneurismorrhaphy may be resorted to in a few cases in which the sac is accessible.

Syphilis is not important in the etiology of the condition; only two cases cured with specific therapy have been reported.

Because of the good results obtained by ligation, medical or conservative treatment is not justifiable. Before the circulation in the internal carotid artery is permanently arrested, the common carotid artery should be temporarily occluded under local anæsthesia. Usually a defective cerebral circulation will be promptly manifested by vertigo or faintness. When this occurs, the ligature should be removed without delay.

Of the forty-two spontaneous aneurisms in the cases reviewed, thirty occurred in women. Aneurism elsewhere is far more common in the males than in females. In a case of carotid aneurism treated by Langenbuch in 1892 an attempt was made to narrow the lumen of the vessel with a silk ligature so as to lessen but not interrupt the flow of blood. Following this procedure the pain and pulsation were less marked.

Of the eighteen aneurisms of the erosive type in the cases reviewed, twelve occurred in males. In this group there were several catastrophes in the treatment. The prompt recognition of faucial aneurism consecutive to scarlet fever, influenza, cervical adenitis, septic sore throat, and inflammatory tonsillar disease is of the utmost importance.

Of the twenty-seven traumatic aneurisms in the cases reviewed, twenty-five occurred in males.

Of the nineteen arteriovenous aneurisms, eighteen occurred in males and eighteen were of traumatic origin. The treatment of this type includes carotid and jugular ligation and, if possible, extirpation of the sac.

In conclusion the author calls attention to the fact that aneurism of the internal carotid artery in its cervical portion is not so rare as was once thought and is not a benign lesion. Operation results in a fair percentage of cures, whereas conservative or internal treatment is almost invariably followed by death. While a spontaneous cure is possible, it is very rare. If disasters are to be avoided, any unilateral lump in the throat should be regarded as a possible aneurism until it is proved to be some other condition.

The article includes the clinical observations made in all of the cases and a detailed report of the more important cases. It is supplemented by a very full bibliography. JAMES B. BROWN, M.D.

BLOOD; TRANSFUSION

Nather, K.: Pernicious Anæmia and Blood Transfusion (Perniziocse Anaemie und Bluttransfusion). *Arch. f. klin. Chir.*, 1926, cxl, 14.

The author reports upon the experiences of the von Eiselsberg Clinic with transfusion of blood in twenty-nine cases of pernicious anæmia.

To determine the compatibility of the blood of the donor and recipient, the Landsteiner-Moss test was used. For the transfusion, in addition to the Oehlecker apparatus, the method of Percy was used as a rule as it requires less preparation than other methods and makes it possible to keep the donor and recipient in different rooms. Although some surgeons warn against them, transfusions given at very short intervals were proved to be harmless. Since in one case another transfusion given after an interval of several months was followed by a severe anaphylactic reaction, it is recommended that in such cases the patient be rendered immune to anaphylaxis before the transfusion is repeated. An attempt was made to accomplish this by an intravenous injection of about 4 c.cm. of the donor's blood on the day before the transfusion was given. The amount of blood transfused each time was between 300 and 600 c.cm., and the greatest number of transfusions was nine.

All of the patients had been sick for a long time and had been treated medically. Of six patients who were almost moribund when the transfusions were given, four died after a few days. Of the two who survived, one, who now has had a remission of eleven months, shows that in no stage of pernicious anæmia is the omission of blood transfusion justifiable. In the case of the others who came to transfusion in the most varying stages of the disease, transfusions were done in series (a series of from three to six transfusions at intervals ranging from one to three weeks). Remissions of most varying duration (from one to nineteen months) resulted. About half of the patients are still alive.

An observation of interest was the fact that a series of patients who were strikingly benefited by the first series of transfusions did not show a favorable result when the transfusion was repeated for recurrence of the condition. The fact that of twenty-nine patients, some of whom were very sick, twenty showed an immediate favorable result after transfusion, demonstrates that blood transfusion is of value for the prolongation of life and the rapid production of a remission. VOLLHARDT (Z).

Carlton, C. H.: Blood Transfusion in Children's Practice. *Lancet*, 1926, ccxi, 850.

This article is based on some 600 transfusions done in 1925 in the Hospital for Sick Children, Toronto. The methods are described in detail. Reactions are rare and can be remedied by proper treatment. The summary is as follows:

1. The transfusion of whole blood by means of glass syringes is an easy and successful operation which may be performed even on the newly born.
2. As a combatant of shock and a corrector of hæmorrhage it is a valuable routine adjunct to many operations performed on children.
3. It guards the newly born child against the dangers of prematurity and hæmorrhage.
4. It may save the life of a child suffering from burns.
5. It is an aid to the treatment of metabolic toxæmias of infancy. MARCUS H. HOBART, M.D

LYMPH VESSELS AND GLANDS

Reichert, F. L.: The Regeneration of the Lymphatics. *Arch. Surg.*, 1926, xiii, 871.

By replantation of a dog's limb it was comparatively easy to follow the regeneration of both superficial and deep sets of lymphatics.

Regeneration takes place as early as four days after operation. From a practical standpoint this fact raises the question as to the possibility of regeneration of lymphatic channels between the first and second stages of the operation for carcinoma as performed by many surgeons. The findings indicate that the primary growth in malignant conditions should be removed before or at the same time that the regional glandular dissection is done.

WILLIAM E. SHACKLETON, M.D.

SURGICAL TECHNIQUE

OPERATIVE SURGERY AND TECHNIQUE; POSTOPERATIVE TREATMENT

Wilson, W. R.: Detoxication in the Treatment of Burns. *Brit. M. J.*, 1927, i, 54.

Burns owe most of their deadliness to toxæmia. Therefore detoxication is indicated in their treatment. The first indication is to induce free exudation, and the second to get the exudate away from the damaged surface. In four of five cases, which he reports, the author used a hypertonic sodium chloride solution and glycerin.

J. Frank Doughty, M.D.

Blair, V. P.: Repair of Defects Caused by Surgery and Radium in Cancers of the Hand, Mouth, and Cheek. *Am. J. Roentgenol.*, 1927, xvii, 99.

Following a loss of tissue from a heat burn, surgical excision, or mechanical injury, a more or less acceptable repair can be made by first removing the scar, or with proper precautions, the granulations down to normal tissue and then filling the defect with the most appropriate available tissue. In planning the repair, the surgeon must consider the appearance and function not only of the area to be repaired but also of the area from which the repair material will be taken. As nearly as possible, lost epithelium, derma, subcutaneous fat, tendons, and resisting fascia should be replaced with like tissues. Transplants of cartilage, bone, and possibly motor nerves may sometimes be indicated. Non-hair-bearing skin is a good substitute for the oral and pharyngeal mucosa.

The same rules apply to the restoration of areas destroyed or damaged by exposure to the roentgen rays or radium, but in practice an added difficulty may arise in these radiation burns and certain chemical burns. In the débridement of these lesions after the elapse of several months there may be difficulty in determining whether unnecessary sacrifices are being made or tissue of doubtful vitality is being left. Old irradiation burns that have been scarred over for several years are not especially bothersome in this respect. In attempts to clean up indolent raw or painful burnt areas that persist in spite of all forms of treatment and neither heal nor make a frank slough, great difficulty may be encountered. In such cases it is better, when practicable, to remove too much tissue rather than too little. If immediate repair is done, it should be done with tissue of a vitality that can easily compensate for a possible lack of healing energy in the tissue upon which it is to be engrafted. A delay of from six to eight weeks before making the transfer of tissues from an irradiated area for an irradiation burn is better practice than the two or three weeks that is ordinarily allowed for other repairs. There may be some question as to the best manner of dealing with exposed necrotic bone that is still attached. As a rule it is not good practice to attempt to excise a dead part of a bone before it separates naturally. On the other hand, bone killed by irradiation separates very slowly. The application of a soldering iron to kill the indolent area and multiple drilling may hurry the exfoliation.

Carcinomatous changes in the irradiated tissues may further complicate the problem. As a rule the simple superficial epitheliomata will not require excision deeper than the subcutaneous fascia and the defect can be repaired immediately. It is usually best to include in the excision the entire area of damaged skin and immediately replace it with a pocket flap or a free skin graft rather than, as has been the common custom, to make a number of small local excisions and apply a Thiersch graft. The neglected epitheliomata and the carcinomata will demand the same excisions or amputations with corresponding glandular excisions as similar cancers arising from any other cause.

Adolph Hartung, M.D.

ANÆSTHESIA

Mennell, Z.: A Question on the Teaching of Ether Anæsthesia: with a Report of Four Deaths under Ether. *Proc. Roy. Soc. Med.*, Lond., 1927, xx, 185.

Complete abdominal relaxation cannot be obtained until the adductors of the vocal cords have been paralyzed. It occurs with the earlier stages of dilation of the pupil. Overstimulation for long periods results in fatigue, a fall in the blood pressure, and shock.

There is a tendency toward a return to the use of chloroform as a routine anæsthetic. It is not true that the only difference between chloroform and ether is that the former causes death on the table and the latter causes it subsequently. Ether is not the only anæsthetic which causes postoperative deaths. Deaths from ether sometimes occur on the table though not with the same suddenness as those caused by other anæsthetics.

Four deaths following ether anæsthesia are reported. Microscopic examination of tissue from three of the patients showed dilatation of all minute vessels, which means death due to bleeding in the tissues. This may be produced in animals by injecting with histamine. Specimens from the fourth case showed that death was due to fat embolism or infarction.

This condition usually occurs in bed-ridden patients.

Merle R. Hoon, M.D.

Duncan, J. W.: Personal Experience with Ethylene Gas in Surgical Anæsthesia. *Nebraska State M. J.*, 1926, xi, 449.

The author made a study of ethylene anæsthesia in 164 cases. He found that ethylene gas induced anæsthesia more easily and quickly than nitrous oxide and that, upon recovering consciousness from ethylene anæsthesia, the patient did not have that feeling of impending catastrophe which so often follows the use of nitrous oxide. The average induction time was a little less than three minutes. After three breaths, no disagreeable odor was recalled by the patient.

The relaxation was not as complete as that obtained with ether, but was much more complete than that obtained with nitrous oxide. Aside from operations in the abdomen, all surgical procedures can be carried out under ethylene anæsthesia without the addition of ether. The patient's color practically always remains pink, and after the induction of anæsthesia the pulse is slowed. Pulmonary lesions do not contra-indicate the use of ethylene.

The author believes that the objection urged against ethylene anæsthesia that it promotes bleeding is not justified. Postoperative gas pains he attributes to the operative procedure rather than to the anæsthetic used. The margin of safety of ethylene is fully as great as that of ether and much greater than that of nitrous oxide.

In conclusion Duncan warns against the use of an open flame or a cautery in the presence of ethylene. Precautions against static spark should be taken by grounding the apparatus.

ANTHONY F. SAVA, M.D.

PHYSICOCHEMICAL METHODS IN SURGERY

ROENTGENOLOGY

Lysholm, E.: A Roentgenoscopic Apparatus for Cross Section and Localization (Roentgenoskopischer Modellierungsapparat Auch Fue Quersektion und Lokalisation). *Acta radiol.*, 1926, vii, 189.

The author describes an apparatus by means of which, during fluoroscopy, it is possible to cut from a bulk of plastic material, models representing the organs of the body. These models are true in shape as well as in size. The construction of the apparatus allows the patient, sitting in a chair, to be turned around simultaneously with and through an equal number of degrees as the plastic material. By screen examination from a distance of 2 meters or orthodiagraphically it is possible to record, with a lead pencil as an indicator, the different outlines appearing on the screen. The indicator is fixed to two arms which are movable at right angles to the rays, and its elongation is formed of a curved metallic wire. The string cuts sections out of the plastic material corresponding to the outlines on the screen. The model is complete when the patient has made an entire rotation.

By the help of a vertically movable indicator fixed to the modeling table, the apparatus can be used also to obtain cross-sections of different parts of the body such as the heart. It further lends itself to the localization of lung abscess or foreign bodies.

Sievert, R. M.: A Circulating Physical Department for Standardizing the Roentgen Radiation Used in Therapy. *Acta radiol.*, 1926, v, 457.

In the Physical Laboratory of Radiumhemmet, Stockholm, there is a Physical Measurement Department the members of which visit the roentgen wards throughout the country to investigate the roentgen apparatus and standardize the dosage. This department has been functioning for six months and seems to meet a long-felt need. The investigation deals with the following factors:

1. The control, accuracy, and economy of the apparatus: (a) the consumption of current, (b) variations of primary voltage and their influence on the total irradiation, (c) the degree of fine regulation for voltage and milliamperage, (d) the reliability of the milliampere meter, (e) the reliability of the kilovolt meter, (f) the filter, (g) the presence of intensity of high frequency, and (h) the durability and suitability of roentgen tubes.

2. The factors which define irradiation and which should always be the same as far as possible. For every filter and voltage used these are: (a) the peak voltage, (b) the voltage curve or roentgen spectrum and deep dosage, (c) the milliampere, and (d) the ionization power of the irradiation.

In order to facilitate the compilation of statistics, the author proposes that the standardization be extended not only to the dosage, but also to several other factors.

Wintz, H.: Experiences with Deep Roentgen Therapy in Urology. *Urol. & Cutan. Rev.*, 1927 xxxi, 9.

Treatment of the prostate gland and the bladder with the roentgen ray is difficult because of the mechanical factors involved. A large part of this article deals with the technique employed by the author to overcome those mechanical difficulties. Seventy or 80 per cent of the unit skin dose is used in benign hypertrophy (adenoma) of the prostate, while 110 per cent is necessary in carcinoma of the prostate gland or bladder. The application of the dose of 110 per cent requires a very exact concentration of the cones of rays from the different portals of entry.

The presence of inflammation increases the radiosensitiveness. In pathological conditions in the prostate, any inflammation of the rectum or bladder must be treated first. After their radiation, care must be taken that no hard fæces irritate the mucous membrane of the intestine, and an abundant fluid intake must be provided to prevent irritation from a concentrated urine.

One of the complications subsequent to the treatment is tenesmus. This appears from three to twelve days after the irradiation. The attack may be made tolerable with belladonna.

Since two irradiations of from 100 to 110 per cent of the skin unit dose is generally necessary in carcinoma of the bladder, an induration œdema is a frequent complication. The loose tissue of the space of Retzius is especially predisposed to this reaction. This induration is fairly harmless of itself, but when the disintegrating tumor of the bladder becomes the site of infection, the danger of a widespread cellulitis of the pelvis is very great. Therefore an ulcer from a burn in the bladder, which occurs in inexact dosage of the carcinomatous portion, may be a very dangerous complication.

In many cases of carcinoma of the bladder Wintz combines coppering with roentgen treatment. The principle consists in distributing particles of copper and copper salts in the tumor and the surrounding tissues by means of electrolysis and cataphoresis from a 3 per cent copper selenium solution in the bladder. The saturation of the tissues with copper increases the diffusion of the radiation and increases the strength of the dose about 15 per cent of the skin unit dose.

No results are given for cases of carcinoma, but sixty-eight of eighty-seven patients with prostatic adenomata were completely free from symptoms one year after the treatment.

CHARLES H. HEACOCK, M.D.

Halberstaedter, L., and Simons, A.: An Experimental Contribution on the Postoperative Irradiation of Malignant Tumors as Regards Wound Healing and the Prevention of Local Recurrence (Experimenteller Beitrag zur postoperativen Strahlenbehandlung boesartiger Geschwuelste hinsichtlich Wundheilung und Verhuetung oertlicher Rezidive). *Acta radiol.*, 1926, v, 501.

In several cases in which large open ulcers were left by the removal of carcinomatous masses by diathermy, one-half of each ulcer was irradiated while the other half was protected by lead.

Although healing in the irradiated area was somewhat delayed, the resulting scar in this area was usually better than that in the part not irradiated.

In one case, after the lapse of a month, foci of recurrence appeared in the part not irradiated, whereas the irradiated part remained entirely free from them.

Colwell, H. A., and Thomson, M. S.: On Some Effects of Primary and Secondary Roentgen Rays upon the Skin of the Frog Tadpole. *Am. J. Roentgenol.*, 1927, xvii, 1.

Exposure of tadpoles in ordinary water to primary roentgen rays for one and one-half hours caused temporary hyperplastic changes in the epithelium with a certain amount of syncytium formation. The maximum hyperplastic changes were noted from twenty-four to eighty-four hours after irradiation. Later, atrophy occurred. Prolonging the time of exposure shortened the period of hyperplasia and caused the degenerative changes to appear more early and to become more pronounced.

The effects of secondary roentgen rays were studied by radiating the tadpole after the colloidal preparation of the heavy metals had been added to the water. The metals used were:

Elements	Atomic Number	Atomic Weight
Copper	29	63.5
Selenium	34	79.2
Silver	47	108.0
Gold	79	197.2
Lead	82	207.0
Bismuth	83	209.0

Ten, 5, and 1 per cent mixtures of a 1:2000 colloidal preparation of the six elements were used. Gold in the 10 per cent solution proved too toxic.

The most striking feature in these experiments was the high degree of hyperplastic change following the irradiation in the presence of colloidal silver and the length of time the condition persisted. The least hyperplasia was seen with the use of copper. Selenium holds an intermediate position between copper and silver. With lead and bismuth, slight hyperplasia occurred, but degenerative changes were most prominent. In view of the very marked effects produced by silver, and to a less extent by gold, it seems probable that some particular range of wave length is responsible for the marked hypertrophic changes.

CHARLES H. HEACOCK, M.D.

RADIUM

Failla, G.: The Development of Filtered Radon Implants. *Am. J. Roentgenol.*, 1926, xvi, 507.

Failla reviews the development of filtered radon implants from the bulky radium applicators inserted into tumor masses by Abbe and others in 1906 and capillary glass tubes containing radon which were used in hollow metallic needles by Stevenson, to the 5⁻, 10⁻, and 12.5⁻ mgm. radium needles and the suggestion of Duane that "bare seeds" be inserted and left permanently in the tissues.

Because of the zone of complete necrosis developing about glass implants with a resulting slough and painful reaction, filtration of the radon implants was attempted. The success of Regaud with prolonged applications of filtered small-content needles encouraged the search for filtered implants. Halberstadter's method of employing thorium-X is described.

It soon became evident that the radon must be collected directly into the metal. Gold was the metal eventually selected. The technique is described. After extensive physical and biological tests it was found that gold implants with a wall 0.2 mm. thick gave most promise of success. Extensive data obtained from ionization chamber readings, fresh butter decoloration tests, rabbit-muscle necrosis experiments made by Cutler, and the practical clinical use of bare seeds are recorded in tables; curves are plotted and extensive comparisons are made.

By comparing the clinical results obtained with glass "seeds" with the experimental data obtained with the use of gold implants, it was finally determined that 3.3-mc. gold implants with walls 0.2 mm. thick would be equivalent to 1.0-mc. glass "seeds."

The author draws the following conclusions:

1. Gold implants with a wall thickness of 0.2 mm. remove 99 per cent of the beta rays and are suitable for intratumoral irradiation.

2. Since 1-cm. bare "seeds" have been in common clinical use, 2-mc. gold implants with a wall thickness of 0.2 or 0.3 mm. should be substituted for the 1.0-mc. glass "seeds" in the transition from glass to gold.

3. The gold implants produce but 59 per cent of the necrosis caused by the glass implants. Moreover, the necrosis caused by gold implants is partial, while that produced by the glass filter is complete. This difference in the type of necrosis probably accounts for the absence of slough and the fact that the pain is much less severe in the use of gold implants.

A. JAMES LARKIN, M.D.

Allen, E. V., Bowing, H. H., and Rowntree, L. G.: The Use of Radium in Internal Medicine: Further Experiences. *J. Am. M. Ass.*, 1927, lxxxviii, 164.

Although the internal administration of radium has fallen into disuse, the authors have been investigating its value in the treatment of certain diseases and for the relief of pain. In a dosage up to 50 micrograms there were no toxic manifestations.

Radium chloride was given thirty-seven times to twenty-two patients suffering from hypertension which in five was graded as malignant and in seventeen as benign. The dosage varied from 10 to 50 micrograms. Care was taken to establish the resting level of the blood pressure by having the patient remain in bed without medicine for three days. The results were compared with those following the use of luminal, sodium nitrite, and "hypertensive" baths. The luminal and nitrite were given in six doses of ½ gr. each. The hypertensive bath consisted of immersion for from five to fifteen minutes in water at a temperature of 105 degrees F.

The most striking result evident in the tables of blood pressure was the response to rest. The effect of radium chloride on the blood pressure was neither more marked nor more lasting than that of luminal or nitrite. In only two cases were the results more than temporary.

The drug was administered for the relief of pain thirty-nine times in twenty-eight cases of various types in doses varying from 10 to 50 micrograms. The most striking effect was produced on the severe and usually intractable pain of thrombo-angiitis obliterans. In seven of the twelve cases there was marked or complete relief from single injections of radium chloride. In the five others there was little or no response. The effect on diabetic neuritis was less marked but nevertheless gratifying. In a group of cases of endarteritis obliterans, neuritis, arthritis, and pruritus vulvæ, the relief was not sufficient to warrant further use of the method. The authors do not recommend its use in cases of thrombo-angiitis obliterans because non-specific vaccines yield even greater relief.

MISCELLANEOUS

CLINICAL ENTITIES—GENERAL PHYSIOLOGICAL CONDITIONS

Rabinowitch, I. M.: Diabetic Gangrene. *Canadian M. Ass. J.*, 1927, xvii, 27.

Rabinowitch gives a statistical study of 1,016 cases observed in the diabetes clinic of the Montreal General Hospital. Gangrene was found in thirty-six (3.5 per cent). Though this may appear to be a small percentage, gangrene has become one of the chief contributory causes of death in diabetes. The death rate from diabetes has decreased in hospital-treated cases, but the incidence of gangrene has not decreased and has accounted for a very large percentage of the total mortality. This is due to the fact that other conditions formerly contributing to the death rate, such as surgical complications, coma, etc., are now fairly well controlled with insulin.

The incidence of gangrene increases with age. In the experience of the Montreal General Hospital, about 25 per cent of diabetics past the age of 70 years develop gangrene. In Joslin's experience, one in every five persons developing diabetes after the age of 70 years also develops gangrene. The readiness with which gangrene develops appears to be related more closely to the period of life at which the diabetes develops than to the duration of the disease itself. It was noted that when the disease developed between the ages of 30 and 40 years, the average time before gangrene occurred was nine and three-tenths years, whereas when the disease developed after the age of 70 years, the average time before gangrene occurred was less than one year.

The association of syphilis and diabetic gangrene is discussed. A statistical study showed that the incidence of syphilis was five times as great in diabetics with gangrene as in those with no gangrene. The discovery of a luetic infection may be of value not only in the prophylaxis and treatment of gangrene, but also in the correct interpretation of the slow healing of wounds following amputations.

Blood cholesterol studies showed that though the cholesterol content of the blood is increased in diabetes, the average percentages found in diabetes with gangrene are of a still greater magnitude. Dietary indiscretions result in a high cholesterol content.

As is well known, diabetics are very liable to sciatica. Pain extending to the toes, coming on suddenly, and at times causing limping should arouse suspicion. Cases with this symptom should not be dismissed with the diagnosis of "sciatica" or "diabetic neuritis" and the suggestion to the patient that if the diet is followed the pain will probably cease. A special inquiry should be made as to whether attacks of pallor or bluish-red discoloration occur in the limb. Such attacks suggest gangrene, especially if the foot is at times pale and cold and at other times congested. The diagnosis of early gangrene is reasonable if the pulse in the posterior tibial artery is obliterated, and is almost certain in the absence of pulsation in the popliteal artery.

In the treatment of early gangrene, rest with dietary and insulin treatment, Buerger's exercise, hot and cold baths alternately, radiotherapy, and decortication of blood vessels have all been tried with strikingly good results but also with failures. Cases of gangrene beyond the stage of recovery may generally be divided into those which unquestionably demand immediate operation and those in which delay may be possible. For the typically foul and infected case with septicæmia, immediate removal of the limb appears to be the only course open. It is the other type of case that presents the greater problem. Though amputation of the limb is the eventual form of treatment, this may be postponed if other conditions which tend to increase the surgical risk are also present. Proper dietary measures and insulin treatment before operation may do much to improve the postoperative course. A most important consideration, however, is the influence of the gangrene on the progress of the diabetes. If, in spite of the local condition, the urine can be kept sugar-free and the blood-sugar normal, the operation may be safely postponed until the surgeon believes that the risk is minimal. However, if the diabetes cannot be controlled, immediate operation is the best course.

JACOB S. GROVE, M.D.

Schreiner, B. F.: A Summary of the Methods and Results of the Treatment of Cancer, Based on a Study of 3,246 Cases Admitted Between May, 1914, and May, 1925. *Acta radiol.*, 1926, vii, 419.

This report is based upon 3,246 cases of malignancy treated at the State Institute for the Study of Malignant Disease, Buffalo, New York, in the period from May, 1914, to May, 1925. The cases are grouped according to the type of lesion as follows:

Condition	No. of Cases
Epithelioma (basal cell)	425
Epithelioma of lip	216
Epithelioma of penis	37
Epithelioma of vulva and clitoris	31
Epithelioma of oral cavity	375
Epithelioma of antrum of Highmore	46
Adamantinoma	8
Epithelioma of larynx	65
Epithelioma of œsophagus	54

Condition	No. of Cases
Epithelioma, branchiogenic	15
Epithelioma of vagina	33
Epithelioma of cervix	519
Adenocarcinoma of cervical canal	16
Adenocarcinoma fundus of uterus	56
Ovarian tumors	32
Cancer of rectum and anal ring	184
Epithelioma of bladder	65
Carcinoma of prostate	75
Carcinoma of thyroid	14
Carcinoma of stomach	60
Carcinoma of breast	531
Kidney tumors	17
Mixed tumors and endotheliomata	41
Testicular sarcoma	22
Hodgkin's disease	46
Leukæmia	25
Round-cell sarcoma	76
Sarcoma (spindle-cell, etc.)	127
Melanotic sarcoma	35

The cases were carefully classified clinically into two groups—those in which the disease was still local and those in which there were regional or disseminated metastases.

Tumors of the skin and protective membranes were divided into three groups, namely, basal-cell epitheliomata, pearl-forming or prickle-cell epitheliomata, and epitheliomata originating from the mucous membranes.

Basal-cell epithelioma of the skin was treated entirely by irradiation. Primary healing resulted in 95 per cent of the cases and healing which lasted for from one to six years in about 75 per cent.

In the cases of epithelioma of the lip a clinical cure lasting for more than three years was obtained in 78 per cent of the cases of Group 1, in which the tumor was confined to the lip, and in 39 per cent of those of Group 2, in which there were regional metastases but the lesion was still movable. In the cases of Group 3, those of far-advanced tumors of the lip with involvement of the lymph nodes and periosteum, no clinical cures were obtained.

Of thirteen early cases of epithelioma of the penis without demonstrable metastases, a clinical cure lasting from two to ten years was obtained in seven. Of twenty-four cases with small metastases in the inguinal nodes, a clinical cure lasting for from one to seven years was obtained in four.

In cases of epithelioma of the vulva and clitoris treated by coagulation and the implantation of radium, a clinical cure lasting up to two and a half years was obtained in four.

Of 375 cases of cancer of the oral cavity which were treated by the implantation of radium emanation and the use of high-voltage X-rays, a clinical cure lasting up to eight years was obtained in from 6 to 50 per cent, depending upon the situation of the primary lesion and the absence of demonstrable metastases in the lymph nodes. Of 235 cases in which the lymph nodes were involved, a cure lasting up to four years was obtained in ten.

Of twenty-three early cases of epithelioma of the antrum of Highmore in which the disease was still local, clinical healing for periods ranging from one to eight years was obtained in five. In twenty-three far advanced cases with metastases, only palliation was obtained.

Of eight patients treated for adamantinoma, four have been clinically well for periods up to seven and a half years.

In all but one of the cases of tumors of the larynx, œsophagus, and branchiogenic remains, only palliation lasting for from six to eight months was obtained. In the one exception, a case of epithelioma of the larynx, the palliation has lasted for four years.

Four of eight patients treated for early epithelioma of the vagina, and two of twenty-five with far advanced vaginal epithelioma have been clinically well for periods up to three years.

Of the cases of epithelioma of the cervix, clinical healing was obtained in 93 per cent of those of Group 1, 56 per cent of those of Group 2, and 27 per cent of those of Group 3. In those of Group 4, palliation lasting for from six months to four years was obtained.

Of seven cases of early adenocarcinoma of the cervical canal, clinical healing for periods ranging up to four years was obtained in four. In the more advanced cases, only palliation resulted.

Cancer of the fundus of the uterus was clinically cured for periods ranging up to three and a half years in about 75 per cent of the operable cases. In cases of recurrence following incomplete operation or due to technical difficulties at the time of operation, the treatment yielded a clinical healing lasting up to three years in about 32 per cent of the cases. In the inoperable cases only palliation lasting for from six months to three years was obtained.

In the thirty-two far advanced cases of cancer of the ovary, no clinical healing was obtained, but in several there was palliation lasting up to two and a half years.

Of the 184 cases of cancer of the rectum and anal ring, healing for from eight months to four years was obtained in eleven.

In the sixty-five cases of cancer of the bladder, an absolute clinical cure lasting for more than two years was obtained in only one, but in the others the treatment resulted in palliation.

In carcinoma of the prostate only palliation was obtained.

Of fourteen cases of cancer of the thyroid, palliation lasting for three and five years respectively was obtained in two.

In inoperable cancer of the stomach, palliation lasting for from six months to two years and four months was obtained.

In early cancer of the breast the treatment of choice at the present time is operation followed by divided doses of high voltage roentgen rays.

In the cases of mixed embryonic tumors of the kidney the results were unfavorable, but in two cases of hypernephroma, palliation lasting for two and three years was obtained. One patient treated for

adenocarcinoma of the kidney recurring after operation was clinically cured for almost two years by the use of high voltage X-rays.

Of the forty-one patients treated for endothelioma and mixed tumor, eleven have been clinically well for periods ranging from six months to five years.

Of twenty-two patients with testicular sarcoma, two have been clinically well for a year following surgery and irradiation and three have had palliation for two years.

No cases of Hodgkin's disease have been cured, but palliation has been obtained in all of the forty-six cases and in one instance this has persisted for five years.

In myelogenous and lymphatic leukæmia, irradiation has proved very satisfactory in bringing about remissions, but the palliation has been of relatively short duration.

Irradiation and arsenic medication yielded apparently a clinical cure lasting for periods up to six and a half years in thirteen of thirty-eight cases of round-cell sarcoma in which the disease was local or has formed only regional metastases. In the further advanced cases—cases of so-called sarcomatosis—only palliation was obtained.

In sarcoma of the giant-cell, spindle-cell, and melanotic types, irradiation has proved of great value.

GENERAL BACTERIAL, PROTOZOAN, AND PARASITIC INFECTIONS

Ashhurst, A. P. C.: The Prognosis of Tetanus. *J. Am. M. Ass.*, 1926, lxxxvii, 2089.

Ashhurst is a firm believer in the efficacy of intraspinal injections of tetanus antitoxin if they are given early. Antitoxin given intraspinally has a specific action on the toxin already in the spinal nerve roots and in the spinal cord. In experiments on rabbits it was found that intraspinal subarachnoid injections of a solution of methylene blue resulted in a staining of the cord and the base of the brain as far as the anterior ends of the optic tracts and even stained the cerebrum in patches. Therefore it is reasonable to suppose that tetanus antitoxin injected into the lumbar subdural space will reach all parts of the spinal cord.

Recoveries from tetanus without the administration of antitoxin by the spinal route are exceedingly few. Deaths occurring when this treatment is given promptly are also very few. Therefore to refuse to employ antitoxin by the intraspinal route is unjustifiable. The diagnosis of tetanus must be made early and the treatment must be very prompt.

The aims of treatment should be: (1) to prevent the further absorption of toxin by abolishing its source, the infected wound; (2) to neutralize the toxin which is being absorbed by the immediate administration of from 15,000 to 20,000 units of antitoxin intravenously; (3) to neutralize that which has been absorbed into the spinal cord by the immediate intraspinal injection of from 6,000 to 10,000 units; (4) to administer enough spinal depressants, preferably chloral and bromides by mouth and by rectum, to exert a physiological effect; and (5) to keep the patient alive by feeding and nursing. All of the antitoxin needed should be given as nearly as possible at one time and as soon after the diagnosis is made as possible. In most cases repeated doses of antitoxin are a waste of a valuable and very expensive remedy. ANTHONY F. SAVA, M.D.

Serigós, E.: Proximal Hydatid Intradermal Reaction; A New Method of Obtaining More Sensitive Reactions (Intradermorreaccion hidatica proximal; nueva procedimiento que permite obtener reaciones más sensibles). *Semana méd.*, 1926, xxxiii, 1374.

In a case of hydatid of the liver, the author by chance made an intradermal injection immediately over the cyst and obtained a very intense reaction. He therefore tested to see whether the reaction is constantly more intense near the cyst. He found that when two injections were made there was always a more intense reaction at the site of the proximal injection than at that of the distal injection. He made the proximal injection over the cyst and the distal one on the inner surface of the thigh or on the forearm. The distal reaction may be entirely negative and the proximal reaction positive. The cyst may be located by inspection or by percussion and roentgen examination.

A cyst of the lung may be localized approximately by making an anterior, a posterior, and a lateral injection and judging the nearness of the cyst from the intensity of the reactions. A similar method may be used for cysts of the brain, one injection being made in the mastoid region and one in the forehead. A negative reaction with the injections made at the usual sites is very persistent in hydatid cyst of the central nervous system.

AUDREY G. MORGAN, M.D.

EXPERIMENTAL SURGERY

Haden, R. L.: Lesions in Rabbits Following the Intravenous Injection of Bacteria from Chronic Periapical Dental Infection. *Am. J. M. Sc.*, 1926, clxxii, 885.

Haden reports a study of the lesions in 1,500 rabbits following the intravenous injection of bacteria from chronic dental infections.

Joint involvement occurred in 865 animals. This consisted in distention of the joint capsule by purulent fluid or multiple hæmorrhages in the synovial membrane and joint capsule.

Kidney lesions occurred in 453 animals. The most common condition was pyelonephritis. Multiple cortical abscesses, acute hæmorrhagic nephritis, subacute parenchymatous nephritis, hæmorrhage into the medulla, and perinephric abscess were also found.

Gross muscle involvement was noted in 315 animals. The lesions appeared as small white streaks.

These were most distinct in recently killed animals and most common in the muscles of the extremities. Sections showed necrosis of the muscle fibers without marked cellular infiltration. Gross hæmorrhages into the muscles were occasionally seen.

Heart lesions occurred in 353 animals. The valvular lesions were almost entirely vegetations. The myocardial lesions consisted of discrete hæmorrhages or short white streaks of necrosis. Often there was an excess of pericardial fluid. Occasionally purulent pericarditis was found.

Lesions of the stomach or duodenum were found in 234 cases. The stomach lesions nearly always showed hæmorrhage with ulceration or erosion. The hæmorrhage in the duodenum was not associated with ulceration.

Gross eye lesions occurred in 204 cases. The most common lesion was an iritis or an iridocyclitis. Multiple hæmorrhages in the iris, limbus, and sclera, cloudy fluid in the anterior chamber, and cloudy cornea also occurred. Pericorneal injection often developed a few hours after the inoculation.

Sixty-two animals showed gross brain lesions. The most common condition was a basilar meningitis. Occasionally multiple cortical abscesses were seen. In rare instances hæmorrhages were found in the cord or sciatic nerve.

Acute splenic tumor was common. Occasionally a splenic infarct was found. Acute cholecystitis was observed in one animal. Tenosynovitis, lymphadenitis, onychia, thyroiditis, hæmorrhagic colitis, and hæmorrhages into the skin were also seen.

This incidence of lesions in animals after the intravenous injection of bacteria agrees quite closely with the lesions due to chronic focal infection observed in man.

Organisms recovered from roentgenographically negative teeth were found to be as pathogenic as cultures taken from roentgenographically positive teeth.

SAMUEL KAHN, M.D.

BIBLIOGRAPHY *of* CURRENT LITERATURE

NOTE.—THE BOLD FACE FIGURES IN BRACKETS AT THE RIGHT OF A REFERENCE INDICATE THE PAGE OF THIS ISSUE ON WHICH AN ABSTRACT OF THE ARTICLE REFERRED TO MAY BE FOUND.

SURGERY OF THE HEAD AND NECK

Head

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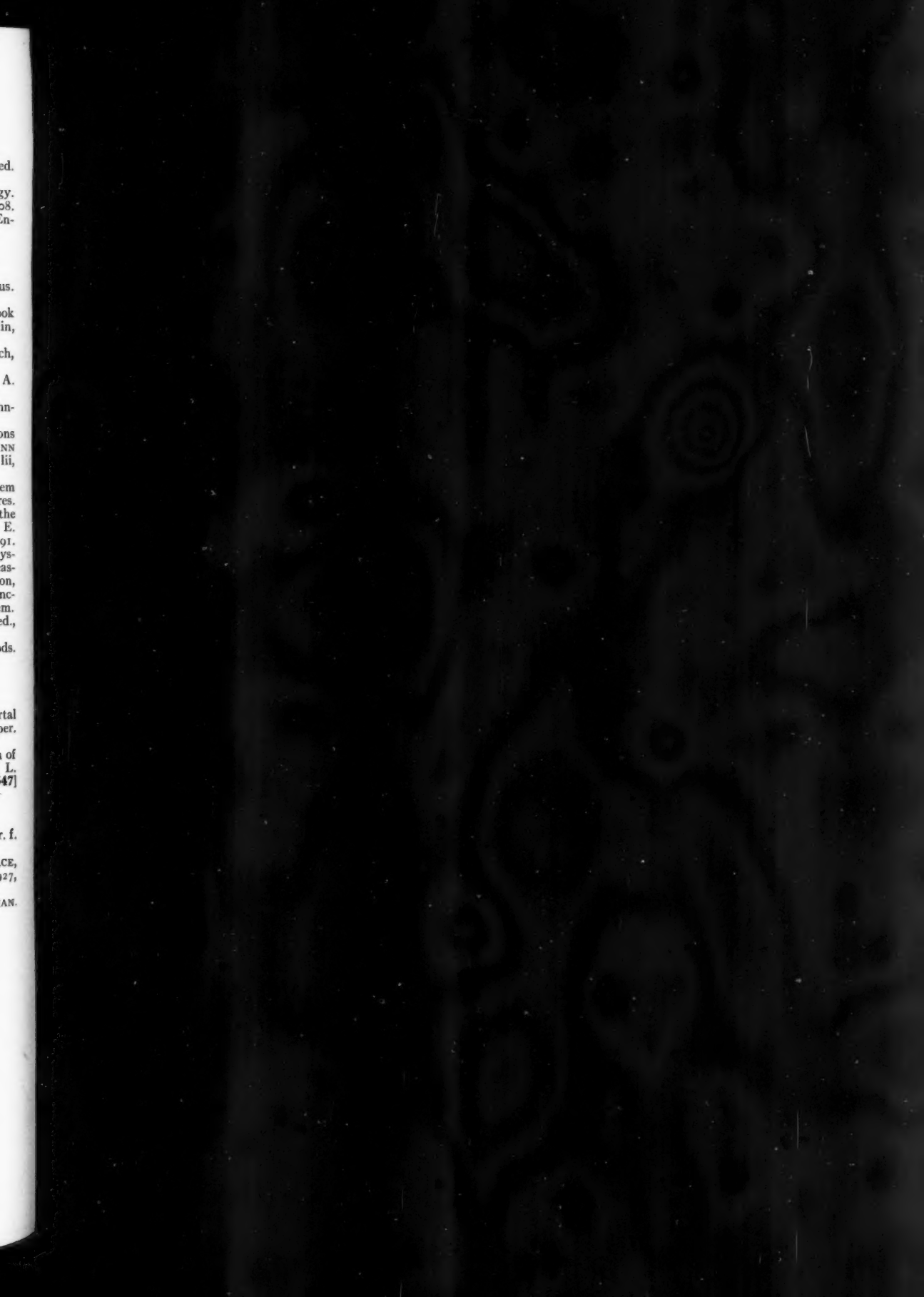

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A STUDY OF THE MATERIAL FROM THE REGISTRY OF BONE SARCOMA OF THE AMERICAN COLLEGE OF SURGEONS

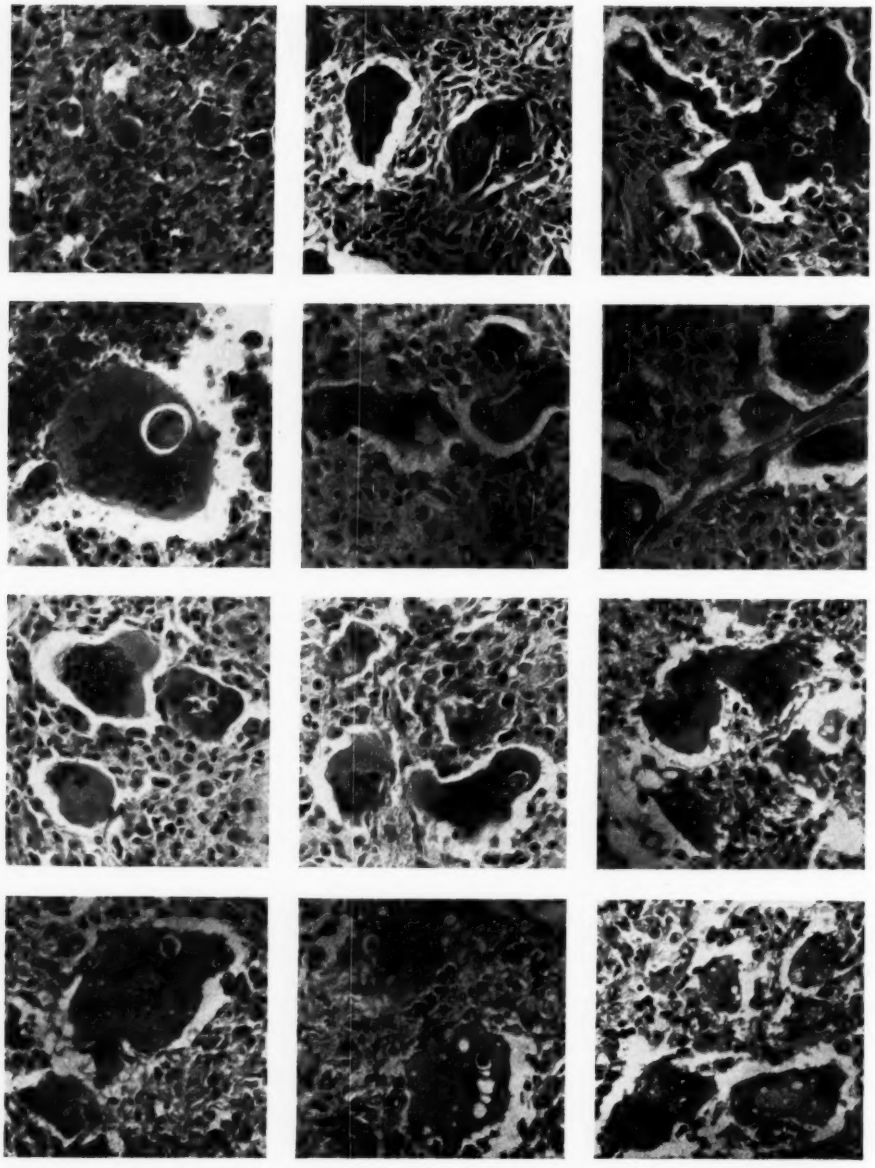

Plate 37. Composed of photomicrographs of cases of giant cell tumor of the Registry collection. Showing vagaries of giant cells of the epulis type. Formation and degeneration of giant cells.

BONE SARCOMA

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THE PRIMARY MALIGNANT TUMORS OF BONE AND THE GIANT CELL TUMOR

BY

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AUTHORIZED BY THE AMERICAN COLLEGE OF SURGEONS
THE SURGICAL PUBLISHING COMPANY OF CHICAGO, PUBLISHER
1927

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RESPECTFULLY DEDICATED

TO

THE ORGANIZER OF THE REGISTRY OF

BONE SARCOMA OF THE AMERICAN COLLEGE OF SURGEONS

AND THE FIRST REGISTRAR

ERNEST AMORY CODMAN, M.D.

Whose tireless work and

idealism has inspired a generation of students

in their

investigation of bone tumors.

"Where facts are numerous and unquestionable, and unequivocal in their significance, theory must follow them as it best may, keeping time with their step, and not go before them, marching to the sound of its own drum and trumpet."

OLIVER WENDELL HOLMES, 1842

PREFACE

THE experience of the Registry of Bone Sarcoma of the American College of Surgeons brought much light in the dark field of malignant bone tumors. For various reasons, however, few clinicians and laboratory men have had the opportunity to study the material and to share in the gains of the Registry. It seemed appropriate at this point to assemble, analyze and critically present before the profession at large the multitude of facts and information gained from a personal study of the 700 cases of the Registry and an extensive review of the literature to date. In consequence of these considerations I attempted to facilitate the comprehension of the frequently opposing opinions by presentation of the views at which I arrived after repeated studying of this material. I court no delusion as to the brevity and inadequacy of the discussion of some questions in this treatise; my desire to present only basic and essential facts as gained from the study of the Registry collection is my excuse. My primary aim is to assist the diffusion of the experience of the Registry as it stands today. I entirely agree with Codman when he says that the opinion of one who has studied "this series of cases could certainly be of help to anyone on whom the responsibility of decision of life and limb rests."

In the chapter on classification I am presenting a critical analysis of the classification offered by the Registry Committee and am suggesting certain changes in it. In the chapter on osteogenic sarcoma I have discussed at considerable length the general principles of the pathological diagnosis and prognosis common to all primary malignant bone tumors. Because of the intimate association of the therapy and prognosis of bone sarcoma these two must needs overlap, so that in osteogenic sarcoma both these chapters are best studied together; in the other tumors both these questions are considered in a single chapter.

While the recognition of the benignity of giant cell tumor has had a clarifying influence and while the description of its pathology has contributed much to a better insight into the concept of this disease, the relation of it to malignant bone tumor is still enshrouded in mystery in the minds of the average clinician and pathologist. Multiplicity of causal modalities brings forth identical phenomena and by virtue of overlapping manifestations of varied origin intricate clinical complexes result. Thus lesions of varied motivation must needs be considered in connection with and in relation to malignant tumors that may bring about a similar diagnostic and prognostic issue. I have therefore included in this mono-

graph the giant cell tumor that occasionally calls forth clinical symptoms similar to malignant bone sarcoma.

The illustrations are selected from the material of the Registry. Only a few roentgenograms are brought in of cases observed by me elsewhere. Not all of the roentgenograms of the Registry chosen to serve as illustrations are irreprehensible from the standpoint of technique; in many instances the technical points essential for a satisfactory reproduction of the roentgenogram had been neglected.

It is a pleasure to give acknowledgment to all those who in this country and in Canada have helped me in securing the roentgenograms for illustrations. I am greatly obliged to Drs. Codman and Ewing for many valuable suggestions. Thanks are due my chief, Dr. Rowan, without whose support it would have hardly been possible for me to give this study the necessary amount of time and work. I am glad to accord credit to Drs. Beye and Baxter who kindly read parts of the manuscript.

ANATOLE KOLODNY.

CONTENTS

PAGE

INTRODUCTION 1

HISTORY 3

ETIOLOGY 5

CLASSIFICATION 8

OSTEOGENIC SARCOMA:

- Pathology 26
- Clinical Course 67
- Diagnosis 85
- Therapy 107
- Prognosis 119

EWING'S SARCOMA:

- Pathology 126
- Clinical Course 137
- Diagnosis 144
- Therapy and Prognosis 149

MYELOMA 155

UNCLASSIFIED SARCOMA:

- Angio-Endothelioma 163
- Extraperiosteal Sarcoma 169

GIANT CELL TUMOR:

- Pathological Concept and Etiology 172
- Pathology 175
- Clinical Course 189
- Diagnosis 194
- Therapy 202
- Prognosis 210

INTRODUCTION

THROUGH the irony of fate the case which led to the organization of the Registry of Bone Sarcoma proved to be a carcinomatous skeletal metastatic lesion. This error is not surprising when one realizes that according to experienced observers at the time of the organization of the Registry in 1920 in about half of all cases diagnosed by the clinician and pathologist as bone sarcoma the diagnosis was erroneous. At that time the necessity of a collective study of the primary malignant bone tumors, maladies so rarely diagnosed correctly, became clear to Codman. Experience and accumulation of data were needed to study the natural history of this disease and to test the value of the various therapeutic measures. A narrow road was ahead of the Registry. While in most diseases with a grave prognosis the histological information is secured from the postmortem examination, in bone sarcoma we have had, in the majority of cases, an amputation or exploratory specimen on which to base our diagnosis during the life of the patient. This fact together with the characteristic temptation to prognosticate the outcome of the case stimulates an effort to trace back the clinical history for diagnostic signs and symptoms for future guidance. Independent of the diagnosis and prognosis given by the Registry the individual case goes on its natural course and the outcome frequently demonstrates the diagnostic and prognostic error of the Registry leaders. Experience is the main asset of the physician and none is so valuable as that acquired by mistakes and errors in judgment. The work of the Registry based upon a study of a wealth of material unequaled in the history of bone tumors has accomplished an immense destructive and constructive task. The numerous various classifications of artificially segregated types and varieties of bone tumors suggested in the literature have been carefully considered and in the main have been rejected and an attempt was made to offer a basis for a new standard classification. The widespread idea of the sanctity and invulnerability of the pathological diagnosis was undermined and the importance of the clinical and radiological findings stressed. The benignity of the giant cell tumor constantly questioned by the amputating surgeon was definitely proved and the necessity of conservative treatment advocated. The subject of bone sarcoma was freed of many misconceptions in the literature filled with statistical data of hundreds of cases of "bone sarcoma," cured by various therapeutic methods.

It would be erroneous, however, to shut our eyes on all the blanks in our knowledge of this most important subject even though it has been studied for six

years by a most efficacious collective method. Much remains to be learned of the pathology and histogenesis of such important lesions as Ewing's sarcoma or giant cell tumor. In the study of these tumors no use has been made as yet of modern methods of hæmatology, tissue cultures, and vital staining which promise much. Our knowledge of the histogenesis of normal bone marrow leaves much to be desired. Even less have we learned of the purely clinical side of the problem; we must have the courage to confess our failure as yet to master these diseases. The treatment of bone sarcoma is just a part of the most important and live problem in medicine today of combating the malignant tumors. The uncertainty of cure of bone sarcoma by any method, the variety of form, both in relative pathological activity, in clinical location and superimposed changes are sufficient to stir one's interest for purely scientific reasons, not to speak of the outstanding clinical importance of the subject.

HISTORY

THE word "sarcoma" belongs to those time-honored terms which are enjoying free general usage in medicine despite the fact that they do not at the present express the original idea suggested by the sponsors of the term. The name sarcoma has been used to designate a tumor with a firm and fleshy feel. The conception of sarcoma a century ago was very wide including all tumors that could not be grouped with other tumors belonging to the few separate entities known at that time. Curiously enough with such a wide conception of sarcoma the tumors known today as bone sarcomata were not included in this group. The superficial gross characteristics of these tumors led to the acquisition for them of such names as fungus, exostosis, tophus, osteoma, and bone cancer. Even Virchow who brought light in most of the dark fields of pathological anatomy and who was the first definitely to separate these sarcomata in a special chapter of oncology did not discriminate sharply enough between sarcoma of bone and cancer. It was Boyer who in 1845 christened these tumors with a name which was destined to follow the development of the knowledge of them up until this day. When at about that time a histological trend of study was directed toward malignant tumors, Virchow described the morphology of sarcoma of bone with clarity and detail surprising for that time. A few years later Robin made an attempt to describe two types of bone marrow cells from which bone tumors originate: the myeloplacque, identified by later investigators as the osteoclast, and the medullocell, later osteoblast. Notwithstanding the confusion by Robin of bone forming and blood forming cellular elements, his was an important step forward in the study of bone tumors; and in the renowned monograph of Nélaton of 1860 the author stressed the importance of the discrimination between the *tumeur à myéloplaques* which is clinically benign and the malignant *tumeur à médullocelles*. These correspond to what we know today as giant cell tumor and osteogenic sarcoma. When a few years later Billroth made the erroneous statement denying the clinical and prognostic importance of the histological peculiarities of sarcoma, Gross (1879) severely criticized him in a brilliant monograph on *Sarcoma of the Long Bones* in which he also emphatically stressed the usual benign course of the sarcomata with a giant cell structure. Years have passed during which the knowledge of malignant bone tumors was at a standstill. Then came the illustrious work of Ewing tending to coordinate the clinical and laboratory sides of the question. In America, Ewing, among pathologists, and Bloodgood, among clinicians, have brought it about that the

giant cell sarcomata of bone have been segregated in a separate sharply defined clinical entity as a benign condition. To do away entirely with the term sarcoma in this disease, the latter was named giant cell tumor. About six years ago on the initiative of the ingenious Codman there came into existence the famous Registry of Bone Sarcoma of the American College of Surgeons which has greatly fostered the study of malignant bone tumors. Today the knowledge of bone sarcoma is yet somewhat nebulous and far from being accurate. The treatment of patients with these diseases is still a matter of ardent discussion and study. On the most important chapter on the origin of these tumors today there is only a dim light. Much is left to be learned in this truly virgin field of science.

ETIOLOGY

IT is a surprising failure of oncology that the knowledge of the etiology of tumors is far behind our knowledge of their structure and natural life. Numerous new theories have been evolved during the last hundred years, many of them purely scholastic inventions without any actual facts to support them. Is there any wonder when old theories which have exterminated themselves because of lack of confirmation are brought to life over and over again under different names? Among the factors underlying this failure are the attempts of pathologists to create theories which would explain the origin of all tumors, whether benign or malignant, carcinomatous or sarcomatous. A study of the clinical and pathological nature of a neoplasm suggests that the etiology of each neoplastic entity is probably specific. It is apparent that Ribbert's theory of the displacement of tissue complexes which explains well enough certain tumors, fails in explaining those numerous instances of tumor growth which follow upon irritation. Opening his famous address on genesis of tumors, Billroth said: "Ueber die letzten Ursachen der Dinge nicht nachzudenken, ist im gewissen Sinne ein beneidenswertes Glueck." No theory explains more than the other; none completely satisfies the inquisitive mind. Whatever theory is favored we cannot free ourselves of the acceptance of a constitutional disposition for tumors. In the course of time the hypothesis of a general disposition of the organism to blastomatosis has been generally conceded.

The etiology of the group of bone tumors known as bone sarcoma has frequently been linked with trauma. Whatever the personal views of the investigator as to the etiology of tumors in general may be, it cannot be denied that trauma seems to be frequently associated with the origin of bone sarcoma. Because of the wide difference in definition of trauma by various pathologists the literature is discrepant in statistics about the clinical incidence and the etiological importance of trauma. The leading question suggesting itself is: "What is the relation between the trauma and the appearance of the tumor?" Refraining from a discussion of the many hypotheses of purely philosophical nature, which lack actual basis, I will outline here the belief to which one is inclined after a study of the osteogenic sarcoma group of the Registry material.

In studying a large series of osteogenic sarcoma one cannot fail to be impressed with the fact that all instances of this tumor may be arranged in series in such a way that at one end will be a mass resembling callus, as we see it after fracture, and at the other a most cellular, highly malignant looking osteo-

genic sarcoma. Cases of osteogenic sarcoma may be identified when the bone absorption, new bone formation, and the vascularity can hardly be told from callus in various stages of bone repair. This observation leads one to believe that the development of osteogenic sarcoma is guided by the same principal laws of growth that are usually observed in the animal organism when in the stage of natural growth or when repair and regeneration are on hand. The main and important specific condition required for the development of an osteogenic sarcoma is a stimulus to growth.

From the fertilized ovum the growth capacity is transferred to the animal tissue cells. As long as the organism is in a stage of physiological development, the cells grow without additional stimuli from the outside. But when the growing organism has reached its adult age—the terminal stage of physical development—the growth tendency of the tissue cells is rapidly interfered with, so that no advanced growth is possible. It is a result of what is known as "growth restraint." The enormous rôle of growth restraint is readily understood when one thinks what would become of the animal organism if growth were not interfered with. The tissue cells in adult organisms do not lose their growth abilities, the latter having merely changed from actual kinetic to potential. On this potential growth ability of tissue cells is based the whole process of tissue regeneration and repair. No life would be possible if the potential growth ability of tissue cells to multiply when repair is needed were lost. Trauma with the consequent necessity of repair leads to a temporary change of the potential growth ability to kinetic, i.e., it leads to a temporary elimination of growth restraint in the traumatized region. In some instances, in the presence of rare predisposing factors which are not understood, trauma may lead to a complete loss of growth restraint in the injured organ. The physiologically accelerated regenerative processes may lead then to a violent multiplication of mesoblastic cellular elements which have entirely lost their main object—physiological repair. The continuous multiplication of as yet undifferentiated cells may be followed by dissemination throughout the organism and by the whole characteristic picture of metastasis of a malignant growth. Regeneration and repair are the main but not only effects of trauma, which have some relation to the etiology of tumors. Separation and isolation of cell complexes, hæmorrhage with conseqeunt absorption and encapsulation, necrosis of tissue—they all play an important part in the etiology of mesoblastic tumors, when brought together with predisposing factors.

Thus it is believed that sarcoma of bone is frequently a result of a loss of growth restraint following an accidental or occupational trauma to a previously normal bone or a surgical trauma to an existing benign bone tumor growth. Not infrequently when the tumor appeared immediately after the trauma or when the primary tumor was noticed after a trauma but not long before a generaliza-

tion of the disease was seen, it is probable that the tumor existed long before the trauma and the latter merely led to the discovery of it or an exacerbation of its growth. The mooted question, not how often sarcoma has a trauma history but how frequently a trauma is followed by sarcoma adds to the discredit of the importance of trauma as an adjuvant etiological factor in an organism predisposed to blastomatosis.

CLASSIFICATION

A SATISFACTORY classification of a disease is the main step to an acquisition of knowledge of it. No science is possible if no uniform language and terminology exist. The lack of progress in the knowledge of bone sarcoma in the last decades is not surprising when one realizes the vast number of various names used for bone sarcoma in different countries, in different centers of the same country, and even by different persons in the same institution. The establishment and propagation of a classification of primary sarcomatous tumors of bone is not merely a responsible but also a most difficult task. As in any other branch of science, there are in the knowledge of these tumors certain time-honored prejudices which have been and still continue to be spread among the workers in this field. A name or an idea, however wrong it may be, is difficult to eradicate if it has decades of history behind it. Furthermore a classification will be of practical value only if it is really accessible to the average clinician or laboratory man. This is especially true in bone sarcoma, a condition with a relatively rare clinical incidence.

Two temptations are presented to anyone who is working on a classification of bone tumors. On one hand there is always a desire to be as complete as possible in the classification, so that no bone tumor would be left in the same group with tumors of a slightly different variety, anatomical or clinical. On the other hand one is tempted to sacrifice preciseness for the sake of simplicity. There have been many victims of this last trend of thought. Billroth was one of them when he said: "The subdivisions made according to the histological peculiarities of the various sarcomata, are of no great value during life." It is a matter of fact that no ideal classification of bone tumors is possible with our present-day limited knowledge of their origin and natural history. Every bone tumor is specific in some way or other, and a classification based upon a distinction of the individual fine points would defeat its purpose by the abundance of groups, types, and varieties, which would vary also with the opinion of each expert.

It is not my intention to offer here a new classification. The classification of the Registry of Bone Sarcoma is the best among the prevailing ones. A study of the Registry material, however, suggests certain changes in this classification. The apparently bizarre fact that the Registry material suggests a classification differing from the one accepted by the Registry Committee can be explained by several factors. In the first place the classification of the Registry was accepted

by the Registry Committee when only a limited number of cases were as yet registered and available for study. In the second place the Registry classification was suggested by a Committee composed largely of laboratory men, hence the presence in it of anatomical points of interest without clinical sequence. Further the purpose of the Registry being the study of all bone lesions diagnosed by anyone as bone sarcoma, the Registry classification includes all pathological conditions of bone and not merely primary malignant bone tumors. In the following, the desirable changes in the Registry classification will be brought out by way of a review and critical analysis of it.

The classification accepted by the Registry Committee embraces all bone lesions under eight headings.

1. Metastatic tumors primary in tissues other than bone.
2. Periosteal fibrosarcoma.
3. Osteogenic tumors, (*a*) benign and (*b*) malignant.
4. Inflammatory conditions.
5. Benign giant cell tumors.
6. Angiomata, (*a*) benign and (*b*) malignant.
7. Ewing's tumor.
8. Myeloma.

Since in the present writing only primary sarcomatous bone tumors are dealt with, the following headings alone will be discussed: Heading 2 (periosteal fibrosarcoma), heading 3 subdivision *b* (malignant osteogenic tumors), heading 6 (angioma), heading 7 (Ewing's tumor), and heading 8 (myeloma). The conditions under heading 1, not being primary lesions, and those under heading 4 and the subdivision *a* of heading 3 being essentially benign conditions, will be touched upon merely insofar as it will be necessary to emphasize the clinical, roentgenological, and pathological points characterizing sarcomatous structures as contrasted with these conditions. The benign giant cell tumors will be dealt with separately. To make the matter clearer, the present analysis begins with malignant osteogenic tumors.

The old term osteosarcoma still prevails in the continental literature, where all sarcomatous tumors of bone are embraced under this name. Osteosarcoma, as used in Europe, does not leave out myeloma, Ewing's tumor, and even giant cell tumor, which are all clearly separate clinical and pathological entities. Like "bone sarcoma," osteosarcoma is a collective name which should not be used in the medical literature when scientifically more precise terms are possible today.

Ewing is responsible for the term "osteogenic sarcoma." All primary sarcomatous tumors of bone which do not belong in any of the other groups of the Registry classification are to be referred to osteogenic sarcomata. "Osteogenic sarcoma" includes mainly the lesions which have been known for long as "perios-

teal bone sarcoma," a term which has spread in this country since the days of Gross, and which does not stand a critical analysis as will be brought out later. In free translation osteogenic means derived from bone. The true meaning, however, of osteogenic sarcoma as understood by those who accept the Registry nomenclature is a sarcomatous tumor derived from ancestors of cells which, when duly differentiated, are known as osteoblasts. An osteogenic sarcoma thus is an osteoblastoma, somewhat as a carcinoma of the skin is an epithelioma. Of course, there is a difference in this analogy between osteoblastoma and epithelioma. While in the latter the epithelial cells composing it are more or less typical and duly differentiated, in an osteogenic sarcoma various stages of development of osteoblasts can be seen, from a simple spindle cell to mucoid, cartilage, and even true bone cells.

Simple and clear as this conception of osteogenic sarcoma is, it is of the utmost importance. It involves a series of questions of primary significance for the etiology and pathology of these tumors. Recently in the French literature opposition was raised against this conception of "osteosarcoma" as the authors call these tumors. Departing from a discussion of questions of physiological ossification and the subsidiary rôle of the osteoblasts in it the authors arrive at a modern conception of osteosarcoma. According to their views these tumors are not osteoblastomata, but sarcomata of the connective tissue cellular elements present in the bone and bone marrow. Thus, no difference is to be encountered between a sarcoma of bone and a sarcoma of a fascia. Modern as this conception is it is contrary to well known facts. The authors have seemingly neglected the fact that pulmonary metastases of osteogenic sarcoma show tumor cells, cartilage, myxomatous tissue, and even bone. Since it is impossible to presume that all the numerous metastatic foci have originated from embryological inclusions of which each contained cells of every variety (myxomatous, cartilaginous, and bone), this fact proves that the tumor cells brought through the vascular system from the primary focus into the lungs have retained the ability of the osteoblasts to differentiate in mucoid, cartilage, or bone cells.

A mistake made very frequently is to understand under osteogenic sarcoma a tumor producing bone. An osteogenic sarcoma does not necessarily mean a tumor in which the tumor cells are forming bone. Production of bone is merely a potential ability of the tumor cells. If the tumor is slow growing and the differentiation of the tumor cells is well expressed they may reach the ultimate goal and become bone cells, otherwise the differentiation may desert them halfway, and they are left as mucoid or cartilaginous cells. They may even remain permanently in their primary stage of spindle cells without any definite arrangement and visible aim. While the tumor cells are undifferentiated and rapidly multiplying they affect a corrosive action upon the involved bone. The bone melts away under the approach of the tumor cell. Later on differentiation of

Fig. 1. Case 312.[1] Osteogenic sarcoma. Photomicrograph of a section taken from the same tumor as in Figures 2 and 3. An area showing the structure of a fibrosarcoma.

the tumor cells leads to bone production, but at the same time the undifferentiated tumor areas continue to destroy bone. It is analogous to physiological bone repair in fractures. The first stage of healing of a fracture is the resorption of the bony spicules and the jagged edges of the fragments. Formation of osteoid tissue with calcification is the next stage, when the provisional callus is formed. Then follows the third stage of resorption and consolidation of the exuberant callus. In non-union of fractures, because of local reasons or constitutional disorders the cellular elements which have been called to activity by the law of repair do not differentiate in bone. They remain at the stage of cartilage or myxomatous tissue or even a fibrous septum is left in the line of fracture.

The subdivision of osteogenic sarcoma in various groups and varieties is an exceedingly difficult task. It is obvious that the single criterion of whether a certain peculiarity of a group of tumors is to be sufficient reason for an exclusion of the group in a separate variety or type, is whether or not this peculiarity influences the clinical course of the tumors. Tumors with a histology which

[1] Most of the illustrations are made from material selected from the Registry of Bone Sarcoma of the American College of Surgeons, and the case numbers all refer to the cases recorded in that Registry. Illustrations taken from other sources are so indicated.

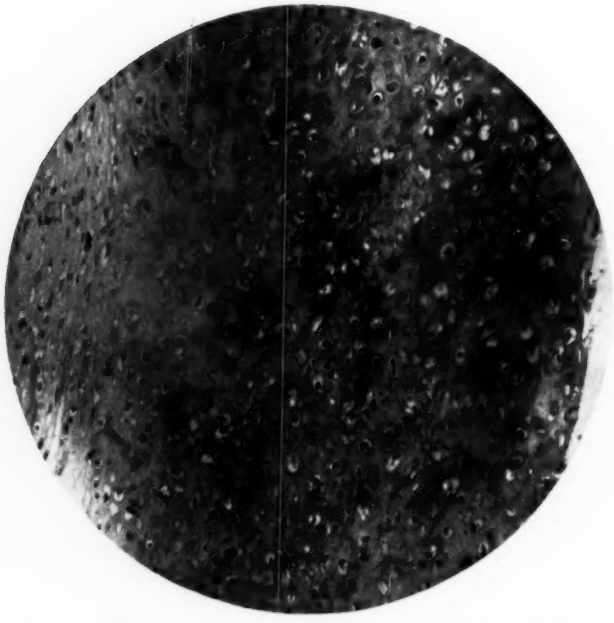


Fig. 2. Case 312. Osteogenic sarcoma. Compare with Figures 1 and 3. An area showing atypical cartilage.

seems to influence their prognosis are apparently entitled to be carried as a special variety or type, separately from the main bulk of tumors. The influence of the structure of the tumor upon the mortality and prognosis and therapy is the only indication for a practical and sound subdivision.

There has long been felt a tendency among students to differentiate sarcomatous tumors according to the variety of the tumor cells and the preponderating tissue which the tumor imitated. Naming tumors on the basis of the features of their cells is inaccurate, because such names do not convey any data of diagnostic importance. Round celled, spindle celled, giant celled sarcomata—they all originate from mesoblastic elements and unless information is furnished as to their origin and clinical peculiarities, these terms are mere sounds lacking any diagnostic and prognostic enlightenment. Naming osteogenic sarcoma according to the specific tissues which the tumor is imitating is also of questionable value. The majority of osteogenic sarcomata studied show a conglomeration of various tissues of mesoblastic origin. If one is not satisfied in the examination of an osteogenic sarcoma by a few sections of one area and one makes an exhaustive study of the whole tumor, one rarely if ever fails to encounter all or several of these tissues (Figs. 1, 2, 3). In one tumor fibrous tissue will predominate, in

Fig. 3. Case 312. Osteogenic sarcoma. Compare with Figures 1 and 2. An area showing low grade bone formation in a cellular tumor.

another osteoid, in still another myxomatous, and in others chondromatous or osseous tissue will preponderate. A diagnosis including a combination of all or several of these tissues preceding the words "osteogenic sarcoma," merely adds to the mystery with which bone tumors are surrounded. They fall short as far as enlightenment on the clinical and pathological diagnosis and prognosis is concerned.

From the tissue complexes which are found in osteogenic sarcoma, myxomatous tissue has enjoyed the greatest independence in the past. Ribbert in Europe and Bloodgood in America have consistently intimated that myxoma belongs to a separate anatomical entity with a specific origin. Ribbert insists that myxoma is not a product of degeneration of a higher grade tissue since similar degenerations are unknown in normal life and therefore cannot be expected in tumors. However, there is on hand sufficient evidence against the independence of myxomatous parts of osteogenic sarcomata. The myxomatous tissue there is merely a phase of differentiation of the mesoblastic elements which are the progenitors of osteogenic sarcoma. A typical fibroma on one hand and chondroma on the other are almost always encountered along with the occurrence of myxoma.

Plate 1. Case 571. See Figure 6. Osteogenic sarcoma in a woman 25 years old. Illustrating the inadvisability of differentiation of periosteal, subperiosteal, and medullary osteogenic sarcomata. The tumor involves the entire transverse diameter of the bone and also surrounds the bone extraperiosteally.

The alleged poorer prognosis of myxoma as contended by Bloodgood is probably due to technical difficulties of eradication of these tumors and not due to their higher potential malignancy. A chemical analysis of myxoma demonstrates the relationship of these tumors to chondromata. Since both myxomata and chondromata yield mucilaginous protein which on hydrolysis yields sulphuric acid and glucosamine (chondroitin-sulphuric acid) they should be related.

The Registry classification recognizes four anatomical types of osteogenic sarcoma: (1) The periosteal, (2) the medullary and subperiosteal, (3) the sclerosing, and (4) the telangiectatic. The spokesman of the Registry, Codman, doubts the advisability of this differentiation, but Ewing, after whose ideas the Registry classification is framed, urges this subdivision because these types are supposed to differ in their gross anatomy, in their microscopic picture, and in their clinical course. From an analysis of Ewing's views as far as the periosteal and the subperiosteal and medullary types are concerned a different conclusion is arrived at. These types are evidently grossly anatomical and the main feature which separates these two groups, as one can judge from the names, is the position in the bone, whether periosteal or subperiosteal. It is obvious that this distinction is valueless as far as clinical diagnosis goes. To state that the exact location of a tumor is periosteal as opposed to subperiosteal and medullary is clinically impossible. To depend for such purposes on the roentgenogram is

Fig. 4. Case 214. Osteogenic sarcoma in a man 37 years old. Amputation was done 1 year after the onset. The cortex is grossly well preserved and one is inclined to group it with subperiosteal tumors without a medullary involvement. However, tissue taken from the medullary cavity shows sarcomatous involvement.

unsafe because even if the average fair roentgenogram shows only an involvement of the periosteum or a subperiosteal tumor with an intact periosteum this is not conclusive. Frequently, when an unusually clear roentgenogram is made of the amputated extremity a more diffuse and extensive involvement can be made out than is seen in the routine examination. There is no satisfactory proof that such circumscribed osteogenic sarcomata really occur with an involved periosteum and intact subperiosteal tissue. Furthermore even if such conditions occur theoretically by the time they attract the attention of the patient they are more or less diffuse. Not only is it impossible to state the exact location of the tumor from the clinical and roentgenological examination, but, very frequently even with the gross specimen in hand it is hardly possible to say with certainty where the tumor invasion stops. Thus it is evident that no clear gross anatomical features distinguish the "periosteal" type from the "subperiosteal and medullary." Neither is the microscopic picture of the periosteal type entirely different from the subperiosteal and medullary. This contention is especially true when one excludes from the group of medullary sarcoma all tumors other than osteogenic. The frequent occurrence of various intercellular substances in the same tumor indicates that the disease is essentially one and the same, whether the bulk involvement is in the periosteum or extends more subperiosteally (Plate 1).

Plate 2. Case 116. See Figure 5. Osteogenic sarcoma in a woman 28 years old. The most outstanding sclerosing tumor in the roentgenogram in the Registry collection. The photograph of the tumor, however, indicates a soft vascular area in the proximal portion of the tumor, and in the medullary cavity. Death with pulmonary metastases 12 years after the onset. Amputation 6 years after the onset and reamputation for local recurrence 3 years later. The roentgenogram was taken 6 years after the onset.

Finally, it goes without saying that a most careful study of the material of the Registry did not furnish any evidence that the prognosis is different in a supposed periosteal osteogenic sarcoma from that of subperiosteal-medullary. In the Registry material if a satisfactory operative and pathological description is given or a good photograph of the gross specimen is present both periosteal and central involvement are seen (Fig. 4). Codman emphasizes this point.

Of all the four anatomical types of osteogenic sarcoma recognized by the Registry classification the "periosteal" has always enjoyed the greatest popularity. Some of the reasons of it have been pointed out above. Another reason is perhaps the fact that an involvement of the periosteum in the roentgenogram is one of the most widely recognized signs of osteogenic sarcoma. To the

Fig. 5. Case 116. Osteogenic sarcoma. The same tumor as in Plate 5. Sclerosing type of osteogenic sarcoma. In proximity to a sclerosing portion of the tumor a cellular area is seen.

inexperienced surgeon or roentgenologist few roentgenograms will suggest the diagnosis osteogenic sarcoma, unless there is the known fan-like structure or at least a lipping of the periosteum—the wedge-like lifting of the periosteum from the cortex of the involved bone. Lipping of the periosteum is a reactive response of the periosteum to bone involvement, and similar lipping is also met with in other than neoplastic bone lesions. However, good roentgenograms from various angles nearly always show it in osteogenic sarcoma and this means that subperiosteal involvement is present.

Investigators who have most consistently urged the recognition of periosteal sarcoma associated this type of bone involvement with the radiating fan-like structure of the tumor in the roentgenogram. It may be said without exaggeration that nothing in the teaching of malignant bone tumors is more popular than this fan-like picture. The idea that this picture is absolute proof of osteogenic sarcoma is widely spread and frequently a clinician will not make the diagnosis of osteogenic sarcoma unless this picture is seen. Facts speak to the contrary; a similar arrangement of the needle-like osteophytes perpendicular to the bone is sometimes found in low grade chronic bone infection, pyogenic or tuberculous.

Plate 3. Case 334. Osteogenic sarcoma in a man 24 years old. The roentgenogram suggests a sclerosing tumor while the gross specimen and the specimen with the injected blood vessels show the exceptional vascularity of the tumor. The roentgenogram was taken 6 months after the onset and one month before a hip amputation was done. Death 10 months after the onset.

Fig. 6. Case 571. Osteogenic sarcoma. The same tumor as in Plate 1. Sclerosing type; close to the acellular tumor mass a cellular area is seen.

Beautiful specimens of macerated bones showing this condition may be seen in the Warren Museum in Boston and in the Army Medical Museum. The presence of these spicules means subperiosteal involvement, as will be seen later, but this is invariably accompanied also by a medullary involvement.

"Sclerosing" is the third anatomical type of osteogenic sarcoma in the Registry classification. The term sclerosing, given by Virchow, means that the tumor sclerosed, the intercellular substance ossified. In the Registry material and also in many cases of private collections studied I saw no case of osteogenic sarcoma in which the microscopic picture of "sclerosis" prevailed throughout the whole tumor (Plate 2). Usually after one or two areas of real sclerosed tumor where only an occasional tumor cell is found, areas are seen where the cellularity of the tumor and the pleomorphism of the tumor cells seem to indicate that no deviation from the grave prognosis of the average osteogenic sarcoma can be expected (Figs. 5, 6). Cases of osteogenic sarcoma studied roentgenologically during the whole natural life of the tumor frequently show at some stage or other, usually in the early beginning a picture simulating sclerosing osteogenic sarcoma (Plate 3). After weeks or months the character of the tumor changes to osteo-

Fig. 7. Case 508. The same tumor as in Plate 18. An exceedingly vascular "telangiectatic" osteogenic sarcoma riddled with large blood spaces.

lytic. Were this tumor examined microscopically in its first osteoblastic stage one would be inclined to group it with the sclerosing tumors, while at a later stage the tumor would turn out to be definitely osteolytic.

The fourth anatomical entity of the Registry classification is the telangiectatic osteogenic sarcoma. As the meaning of the word suggests, this type is characterized by abundant blood vessels and spaces. In the extreme variety of this type when large blood vessels make up the main bulk of the tumor, and when only a thin wall of tumor tissue surrounds these blood spaces, a pulsation of the tumor may be felt (Fig. 7). In the old literature this variety of tumor was known as "bone aneurysm." The walls of the dilated blood channels being very thin and consisting of a single layer of endothelium, it is readily understood why a definitely poorer prognosis is to be expected in such cases; there is an immense opportunity for the malignant tumor cells to break into and to spread through the vascular system to the lungs. Like sclerosis in osteogenic sarcoma telangiectasis is a relative feature, all transitional stages being encountered between tumors with a poor blood supply and exceedingly vascular tumors. Telangiectatic is therefore also relative and not a definite separate type of osteogenic

sarcoma. It is obvious that telangiectatic is a postoperative or postmortem diagnosis; clinically and radiologically this diagnosis is usually impossible. Just as sclerosing is an extreme of differentiation of the tumor intercellular substance, telangiectatic is an extreme in the richness of the vascular supply of an osteogenic sarcoma.

Under heading 2 of the Registry classification is listed "periosteal fibrosarcoma." Under this term a sarcoma is understood which, though intimately related to the periosteum, leaves the cortex of the bone intact. Only very rarely the cortex of the bone is slightly eroded, the erosion taking place at a later date in the progress of the tumor. Thus, these tumors are extracortical, frequently surrounding the bone for a considerable distance. Virchow called attention to the fact that usually these tumors are found at points of bone insertion of tendons and dense fasciæ. The majority of these tumors present a typical dense fibrosarcoma. In the Registry material under "periosteal fibrosarcoma" are grouped also instances in which the origin of the tumor could not be established with certainty. A well ascertained true example of a sarcoma originating from the outer layer of the periosteum is up to the present day unknown in the Registry material. The "periosteal fibrosarcoma" cases registered however bear out the fact that this tumor is of a decidedly better prognosis than osteogenic sarcoma. It is easy to see that the term "periosteal fibrosarcoma," accepted by the Registry Committee, is unsatisfactory for important reasons. The word "periosteal" readily raises in one's mind associations with "periosteal osteogenic sarcoma," a tumor of an entirely different origin, microscopic structure, and mainly different clinical course. The Registry Committee seems to have realized it and has attempted to avoid confusion by adding the word "fibrosarcoma" to "periosteal." V. Rindfleisch has pointed out that the origin of "periosteal fibrosarcoma" is from the "fascicular" layer of the periosteum, while the "periosteal osteogenic sarcoma" originates from the cambial layer. In the literature two other terms are mentioned for this tumor: "parosteal" and "extraperiosteal." Of these two I prefer the latter. "Parosteal" conveys rather an idea of a process spreading along lines parallel to the bone; parosteal sarcoma is a sarcoma of a fascia or muscle rather than of the periosteum itself, while "extraperiosteal" seems to emphasize the origin of the tumor from the "external" fascicular layer of the periosteum.

The sixth division of the Registry classification is "angioma." Two subheadings are given there: the benign angioma and the malignant. Of the second subdivision, the malignant, which alone is to be considered here, no cases are registered with the Committee. The Registrar, Codman, believes that this type, angiosarcoma as he calls it, is exceedingly rare if it exists at all; most angiosarcomata from the literature he regards as telangiectatic osteogenic sarcomata. It is true that much confusion was aroused in our knowledge of tumors

of the vascular system by the term "angiosarcoma." This term, given by Kolaczek, originally was intended for the so-called peritheliomata, tumors originating from the vessel wall and not from the endothelial lining of the vessel. Later this term found its way to tumors with a clear endothelial origin, which are better called angio-endothelioma. Unfortunately the very lax requirements instituted by Golgi and Kolaczek for a diagnosis of an endothelioma have led to frequent diagnoses of endothelioma in cases in which no such condition was present. This fact greatly discredited the angio-endotheliomata as an actual anatomical entity in the eyes of most leading pathologists. The majority of pathologists are unwilling today to diagnose an angio-endothelioma even when all evidence is before them. Because of this skepticism instances of true angio-endothelioma slip by under various other diagnoses. This is also true of angio-endothelioma of bone. During the study of the Registry material I found two cases of primary angio-endothelioma of bone which had been passed by the majority of examiners as metastatic tumors. Angio-endothelioma of bone is a malignant tumor of the vascular system of bone with a typical microscopic structure and a definite origin from the endothelial lining of the vessel wall.

I realize that the rarity of skeletal angio-endothelioma would not justify a segregation of this condition as a separate clinical entity in a classification of practical clinical importance. In a large series of malignant bone tumors a careful study will occasionally mark instances which will be difficult to classify according to their anatomical structure and clinical behavior. Obviously such instances cannot be all brought out as clinical entities if the classification of such an obscure condition as bone sarcoma is to remain clear and digestible. Such instances must be pigeonholed awaiting accumulation of more accurate knowledge of bone tumors in general. To such a group of "unclassified tumors" it would be well to carry the angio-endothelioma of bone which although a clear anatomical entity is too rare to justify a separate heading in the classification. It is probably best to list under this group also the extraperiosteal sarcoma (periosteal fibrosarcoma of the Registry classification), true representatives of which seem to be very rare. To this group should belong also such questionable cases as No. 420 and No. 349 of the Registry collection, the first a tumor resembling somewhat a giant cell tumor in the primary and pulmonary metastases but not typical enough of a true giant cell tumor structure, and the latter a true giant cell tumor which, following multiple operations and ill advised therapeutic procedures, was transformed into a distinct malignant tumor and gave pulmonary metastases.

The seventh division of the Registry classification is "Ewing's tumor." The knowledge of this entity, scarce as it is, is unfortunately limited only to those who have studied the Registry material. This fact however is not surprising when one recalls that only in 1920 was this tumor established by Ewing as an anatomical and clinical entity among the malignant bone tumors. Pathologists

unfamiliar with bone tumors have been for long submerging and still continue to submerge Ewing's tumor under the diagnosis of round cell sarcoma or solitary myeloma. A specific clinical course, a typical gross anatomy, and a unique histology serve as the basis for the existence of this entity. In studying the Registry material even without any thought of classifying the tumors it is surprising with what ease the impression grows in one's mind that these tumors represent a clear-cut separate disease. This tumor affects young patients, rarely above 21 years of age. It frequently begins with a clinical picture resembling acute osteomyelitis, a reason why in the majority of cases this mistake in diagnosis is usually made. The response of the tumor to radiation, whether roentgen-ray or radium is remarkable; however, permanent cure from radiation is as yet unknown. Metastases to other bones is a characteristic feature of the terminal stage of this tumor in divergence with osteogenic sarcoma in which bone metastases are very infrequent. The histological structure of the tumor is at variance with any variety of osteogenic sarcoma. Ewing suggests the origin of the tumor from the endothelium of the bone marrow. In connection with this he suggests a wider scope of cellular elements for the term "endothelium," since he admits that the vascular endothelium bears no relation to the origin of the tumor. Deferring for the present time a detailed discussion of this question it will suffice to say that no proof has as yet been accumulated to support Ewing's hypothesis of the endothelial origin of this tumor. The term "endothelioma" under which this tumor frequently appears tends to confuse it in the minds of the occasional observer with angio-endothelioma. If Ewing's tumor is in any way related to the endothelium of the bone marrow it is an "endothelial myeloma" and it should not be called "endothelioma." It is most satisfying to see that the Registry classification has refrained from either term, endothelioma or endothelial myeloma. However the term Ewing's tumor decided upon by the Registry Committee is not well chosen and is incompatible with the intention of the Registry to reserve the word "tumor" for a giant cell sarcoma which is essentially benign. In giant cell sarcoma the word sarcoma has been replaced by the word tumor in order to emphasize the benign nature of the lesion. The lesion understood by the Registry Committee under Ewing's tumor is a true malignant condition and the retaining of the word sarcoma would cause less confusion as to the clinical behavior of the tumor. For this reason I am of the opinion that Ewing's tumor should be substituted by Ewing's sarcoma until a time when we learn more of the nature of this condition, more of its origin and its morphological ancestry. For the present, whatever the morphological nature and the origin of this tumor, it is undoubtedly a clinical entity and as such it is entitled to an independent place in the classification.

"Myeloma" occupies the eighth division in the Registry classification. This is a tumor originating in the medullary cavity of a bone, appearing simultaneously

as numerous nodules ranging in size between the size of a pin head and that of a walnut. The large majority of myelomata are multiple tumors, only one solitary tumor having been recorded by the Registry during the six years of its existence. This tumor is held to be derived from the specific bone marrow cells of the myelocyte series. Myeloma is the only true round cell tumor occurring in bone. Because of its multiple character myeloma was recognized long ago as a systemic disease, and this recognition led to a view that myeloma is not a true tumor but is to be regarded as in some relation to the pseudoleukæmic or aleukæmic group. For purposes of classification there is no need to enter a discussion of all the fine details of the derivation or etiology of myeloma. There are characteristic features which stamp myeloma as different from osteogenic sarcoma. Myeloma is a bone marrow tumor characterized by multiple foci of origin, by frequent albumosuria and rare metastases, frequently affecting short bones, and especially favoring the ribs, sternum, vertebræ, and skull. When situated in long pipe bones, it favors midportions rather than the ends of the bones. Myeloma recedes rapidly under radiation but no permanent recovery by radiation is recorded. In many of these features myeloma resembles Ewing's sarcoma, from which it is easily distinguished because of its morphology and different radiological appearance. The wide destruction of the bone marrow leads to early cachexia and anæmia, and because of the rapid resorption of bone, fractures and infractions occur early and frequently. Attempts at subdivision of myeloma into separate types according to a variation in morphology has met with much opposition. The present day knowledge of the fine points of morphology of myeloma is limited. Subdivisions according to histological features offer no therapeutic indications. Despite the divergence in the histological structure all these types belong essentially to the same disease entity.

As a conclusion to the above discussion all primary malignant bone tumors can be subdivided in the following groups:

1. Osteogenic sarcoma.
2. Ewing's sarcoma.
3. Myeloma.
4. A group of unclassified sarcoma including among others such "near entities" as angio-endothelioma and extraperiosteal sarcoma.

No subdivisions of the main groups in types is recommended. Slight as are these changes of the Registry classification insofar as sacrifice of accurate knowledge for the sake of simplicity is concerned, they are important because of the clearness with which they present the classification of this most confused chapter of oncology. That these changes are justified theoretically was pointed out in the analysis of the Registry classification. From the practical point of view there can be no doubt that these changes render the classification of the primary malignant bone tumors more understandable for the roentgenologist and patholo-

gist and especially for the clinician, who is ordinarily relatively inexperienced in bone tumors.

This modification of the Registry classification is not to be considered as wholly satisfactory and final. No clear cut or hard and fast rules are possible in dealing with such a confused problem as malignant tumors of bone. There is no assumption on my part that in the future with the advance of our knowledge of these tumors it will not be found advisable to subdivide these four entities into groups and types with a peculiar histology, origin, and clinical picture. When a classification of a group of pathological conditions, as in bone tumors, precedes the acquisition of exact knowledge of these conditions the only way a classification can proceed is the deductive one, by dividing the general group into narrower and more specific classes. This explains why sometimes bone tumors are encountered when it is difficult to include them in any of the divisions of the classification. In the present classification these tumors are grouped under the "unclassified." The number of individual cases in this group is not large and with the advance of our knowledge will decrease still more. Occasionally the question will arise whether to group them with one or the other division. These are the so-called borderline cases, which, with all clinical and radiological data and the gross specimen before him, and with the section under the microscope, one hesitates to place in any certain group. The question of the decision of the exact nature of a borderline case is especially difficult when the diagnosis rests between a malignant tumor with a very grave prognosis and a benign condition, whether a tumor growth or an inflammatory process. In these cases the pathologist's answer is most decisive and therefore most responsible as far as the therapeutic and especially prognostic indications are concerned. *Natura non facit saltum* and there may be expected all transitional stages from a benign condition to the most fatal tumor growth. No classification can with advantage consider similar problems as long as our knowledge of bone tumors is so meager, and our experience so fallacious. However, at present I agree with Codman that any pathologist who has studied the Registry material with care will make a satisfactory diagnosis and prognosis in over 90 per cent of the cases presented to him, provided the data are technically good.

OSTEOGENIC SARCOMA

PATHOLOGY—*Gross Anatomy*

THE pathology of primary malignant tumors of bone embraces the gross anatomical picture of the tumors and their histological structure. Unlike other pathological conditions the gross anatomy of these tumors is more complicated because of their location in such a dense unyielding organ as bone. Because of the great resistance to the spread of the tumor offered by the bone and also because expansion of the bone alone is far insufficient for a progressive growth of the tumor, the gross picture of these tumors is exceedingly peculiar. This is especially true of osteogenic sarcoma—that main group of primary malignant tumors of bone.

As was pointed out in the chapter on classification a distinction between central, subperiosteal, and periosteal osteogenic sarcoma is unfounded. An osteogenic sarcoma is a diffuse process of the involved bone and there is no way to determine precisely the origin of the tumor, i.e., whether medullary or periosteal. Of course there is always a period in the history of an osteogenic sarcoma when the most active growth of the tumor is especially pronounced in one certain area of the involved bone, whether it be the medulla, cortex, or periosteum. It is evident that the gross picture will be influenced as to whether the tumor grows more rapidly in the region of the medullary cavity or close to the periosteum. In the first case the bone cortex will exercise resistance to the spreading of the tumor for a much longer period of time than in the last case, when the periosteum will be reached and perforated by the tumor at a much earlier date. It is evident therefore how erroneous it is to accept as the origin of the tumor the center of the tumor mass, which in many cases even late in the disease is confined by the cortex although the latter may be perforated in many places.

To understand the capricious features characteristic of osteogenic sarcoma one has to keep in mind the main factors which influence the gross picture, shape, and consistency of these tumors. The foremost place among these factors is occupied, on one hand, by the continuous aggression of the tumor elements and on the other by the defensive protective measures of the involved bone against the growing tumor. The degree of differentiation of the tumor elements, the vascularity of the tumor and the regressive changes in it are factors greatly influencing the consistency of the tumor.

The aggression of the tumor cells and the defense of the involved bone may be noticed in every case of osteogenic sarcoma. The natural instinct of the tumor—to grow and to increase in size—leads to more or less destruction of the bone in the involved area. Destruction of the bone to a greater or lesser degree is a condition *sine qua* there is no osteogenic sarcoma. The attempts of the tumor to extend are directed in two ways—one is toward the outer aspect of the bone and the other is along the medullary cavity. This latter direction is a point of less resistance, because of the loose structure of the bone-marrow and also because the endosteum does not exercise as much activity to protect the medullary cavity from invasion of the tumor as the periosteum does against perforation of the cortex into the surrounding tissues. This explains the fact that cases of osteogenic sarcoma are seen in which the medullary cavity is literally stuffed with tumor from end to end while the radiograph indicates a tumor wholly limited to the area of involvement of the cortex and periosteal reaction.

The self defense of the involved bone is taken over by the periosteum. The periosteal reaction in osteogenic sarcoma is the only morphologically evidenced attempt of the organism to protect itself against this extremely malignant condition. The periosteal reaction is especially well expressed when the tumor is located in its most frequent situation—the metaphysis of a long pipe bone. It is much less striking when the tumor is located in the shaft or in those rare cases when it is situated in the epiphysis proper. The periosteal reaction of a bone involved with an osteogenic sarcoma consists in formation of new bone, apposed on the outer surface of the cortex of the involved bone. This apposition of new bone leads to a gradual thickening of the bone. Gradually the tumor breaks its way through the old cortex by way of the Haversian system and encroaches upon the newly apposed periosteal bone which it gradually displaces. Slowly the tumor spreads subperiosteally along the surface of the bone. The periosteum is being pushed away from the underlying bone by the newly produced protective osseous tissue and especially by the growing tumor mass. Nothing interferes with this elevation of the periosteum except the defensive lipping to be described later until the stripping off of the periosteum reaches the epiphyseal line. Because of the most intimate attachment of the periosteum to the epiphyseal cartilage here the elevation of the periosteum comes to a stop and further growth of the tumor leads to a club shaped enlargement of the epiphyseal end of the spindle. It is of sufficient diagnostic importance to remember that in osteogenic sarcoma the old cortex is frequently seen passing through the tumor mass appearing grossly intact. Permeation rather than perforation of the cortex expresses better the pathological process. In this, osteogenic differs from Ewing's sarcoma, in which the bone generally is broken up and displaced by the tumor.

The gross structure of the tumor mass consists of stalactite-like rods of hyaline osteoid and osseous tissue arranged like the spikes of a wheel perpendicular to

the long axis of the involved bone or like fluffy trabeculæ spread beneath the periosteum on top of the cortex of the involved portion of the bone. In the radiograph the first structure is represented by the classical sun-ray-like appearance.

Not infrequently the periosteal reaction is expressed in only slight bone production. This is common in osteogenic sarcoma of the shaft. The rapidly enlarging tumor leads to an elevation of the periosteum from the involved bone in the manner outlined above, but the periosteum is unsuccessful in forming a true bony capsule about the tumor. Only at the polar ends of the grossly fusiform swelling which are farthest from the most active portion of the tumor, the periosteally new formed bone has temporarily escaped destruction. In the radiograph this new formed bone with a jagged edge gives the picture of "lipping," which is a cardinal sign of osteogenic sarcoma not yet sufficiently appreciated (Plate 4). Physiologically this lipping is a result of stretching of the periosteum by a mass intruding between the bone and its periosteum. In a periosteum put under tension the osteogenic capacity is greatly stimulated. Hence such a lipping is sometimes encountered in merely traumatic conditions when a hæmorrhage strips away the periosteum from the bone. Thus, while lipping is a sign of malignancy, it is not in itself a result of malignant tissue. In the extremely rapidly growing osteogenic sarcoma lipping is less distinct, the lips are poorly formed because of a lack of time for their formation and also because of the extremely intense bone destruction.

In cases with a rapid growth of osteogenic sarcoma and a weak periosteal reaction pathological fractures are encountered. Such fractures at once give an outlet to the expanding tumor by tearing the periosteal capsule. The tumor then enters the ultimate phase in its local development, infiltration of the surrounding soft tissue. More frequently, however, than through a pathological fracture, an osteogenic sarcoma reaches this final stage by way of perforation of the periosteal capsule. The continuous stretching of the periosteum by the tumor expanding beneath it finally leads to a perforation of the periosteum at some point. The tumor changes its main direction of expansion along the bone to a centrifugal infiltration of the surrounding tissue. A longitudinal section through a tumor at this stage shows the involved bone with the tumor mass spreading along it, intramedullary and subperiosteally, and externally to the periosteum, the most recent tumor mass connected with the main tumor by a pedicle through the perforation. In perforation through the periosteum of osteoblastic osteogenic sarcoma, when the subperiosteal portion of the tumor consists of the stalactite strands of hyaline osteoid and osseous tissue, the extraperiosteal portion of the tumor loses this radiation structure and the osteoid and osseous tissue of the tumor here has no evident orderly arrangement.

After perforation of the periosteal capsule has taken place, nothing more stands in the way of the aggressive tumor. Muscles are stretched, thinned, and

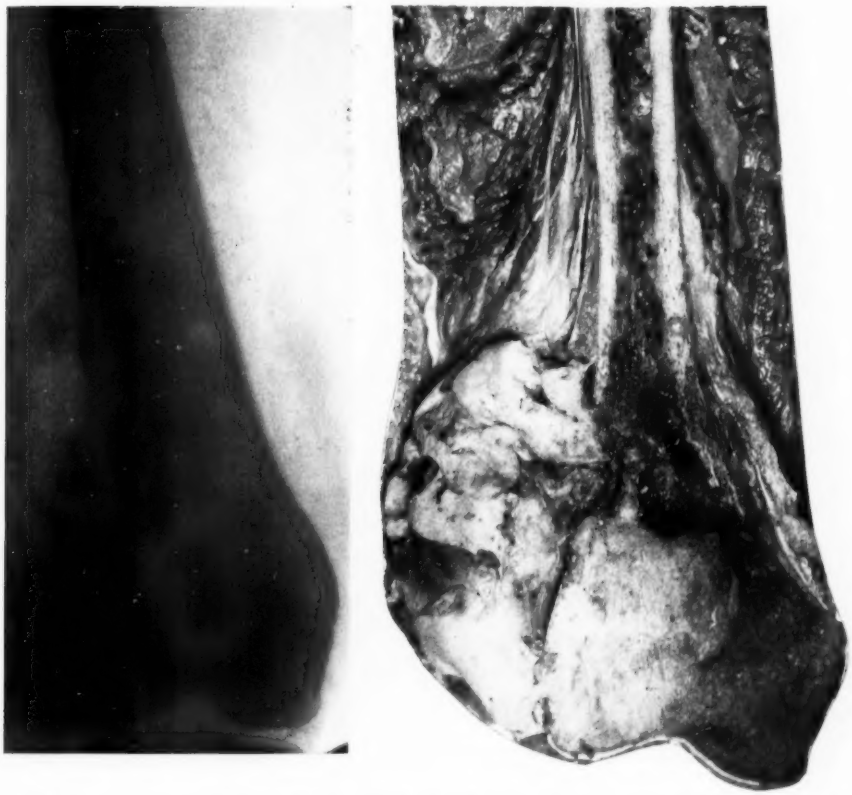


Plate 4. Case 43. Osteogenic sarcoma in a girl 17 years old. Osteolytic variety. The photograph shows invasion of the epiphysis and lipping of the periosteum.

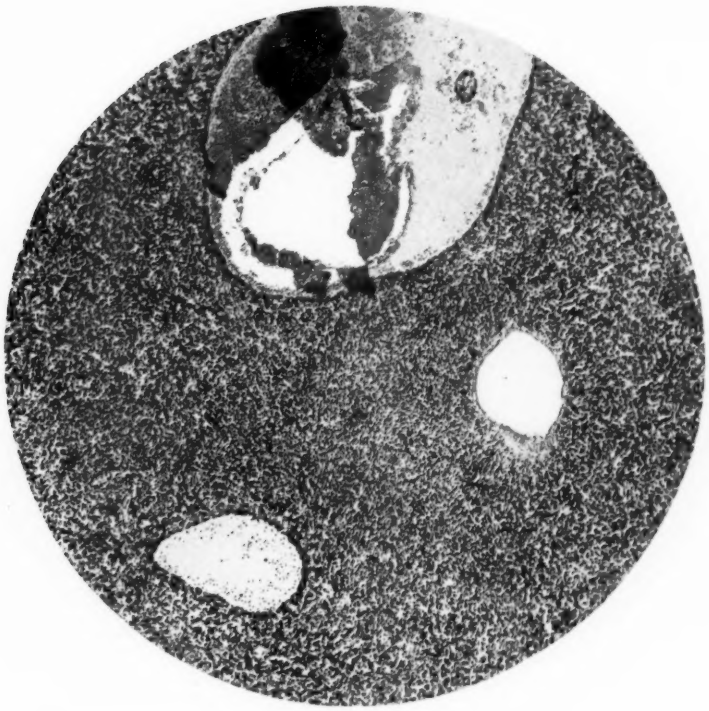
atrophied so that it is not unusual to find the tumor covered merely with glossy skin. Ulceration of the overlying thinned out skin is unknown in osteogenic sarcoma; it is simply stretched and atrophied. Even more resistant to osteogenic sarcoma than skin is cartilage. Articular cartilage and cartilage of the epiphyseal junction offer more resistance to the aggressive tumor than any other tissue in the human body (Fig. 8). The best explanation of it is probably the absence of vascular channels in cartilage. As a matter of fact in adults with ossification of the epiphyseal line an involvement of the epiphysis by an osteogenic sarcoma of the metaphysis takes place relatively early, while in young individuals an extension involvement of the epiphysis is more likely to take place by the indirect route of perforation of the metaphyseal periosteum and secondary involvement of the epiphysis from without than by direct extension through the car-

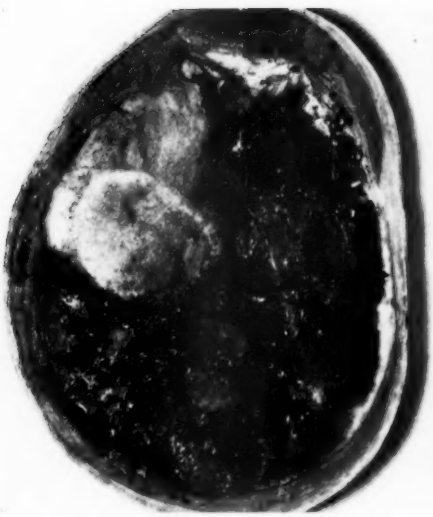
Fig. 8. Case 498. Osteogenic sarcoma. Illustrating the resistance of the articular cartilage to the tumor invasion. A layer of spongiosa is seen between the tumor mass and the articular cartilage.

tilaginous epiphyseal line. In approaching the articular cartilage the tumor destroys all the bone, leaving a thin layer of spongiosa which separates the cartilage from the tumor mass. In this respect osteogenic sarcoma differs from giant cell tumor where the cartilage is frequently in direct contact with the tumor. However instances are known when the entire articular cartilage *en masse* was found separated from the underlying bone destroyed by the tumor which was infiltrating the joint cavity.

Perforation of an osteogenic sarcoma into the joint with an actual involvement of the articular synovia is not rare in far advanced cases complicated with a pathological fracture or by surgery in a region close to the joint. More unusual is a spontaneous involvement of a joint without a preceding pathologic fracture. After perforation into the joint cavity the tumor grows freely and a subsequent involvement of an adjoining normal bone is known to occur.

It is easy to see that an exploratory incision or incomplete local excision of an osteogenic sarcoma readily changes the entire course of the disease. The perforation of the periosteal capsule, long awaited by the tumor, is brought about in these cases by the surgeon himself. Articular involvement in similar cases is not infrequent.





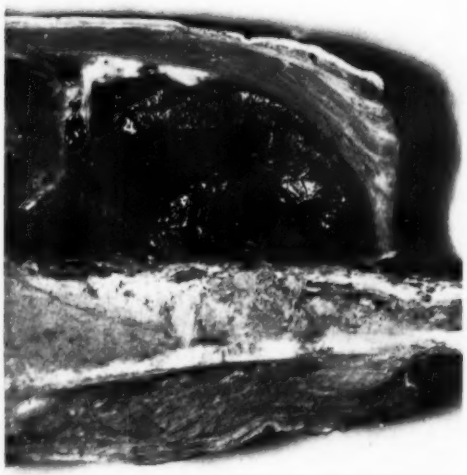


Plate 5. Case 98. See Figure 28. Pulsating osteogenic sarcoma; "malignant bone aneurysm" of the old authors.

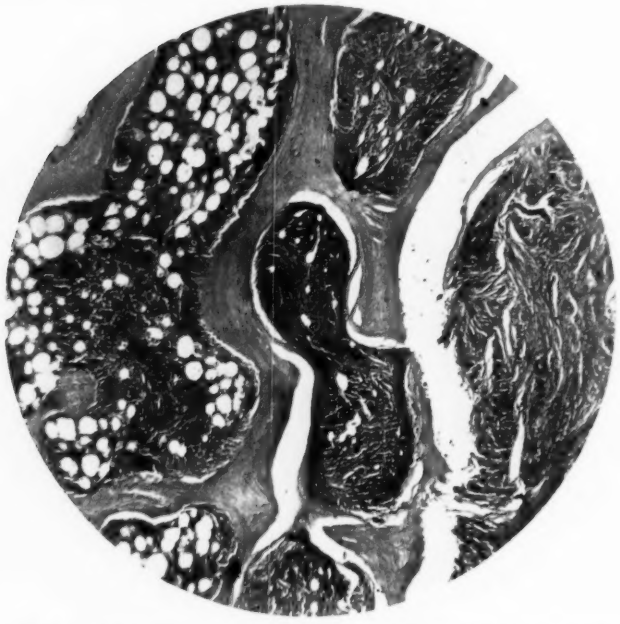


Fig. 9. Case 623. Osteogenic sarcoma. Showing the structure of the so-called medullary fibrosarcoma; an osteolytic variety of osteogenic sarcoma.

The consistency of an individual osteogenic sarcoma is influenced chiefly by the degree of differentiation of the elements constituting the tumor. The great variety in consistency an osteogenic sarcoma may attain is best understood if one thinks of all the changes in consistency which may be presented by immature callus in which the differentiation was interrupted at some stage of development. There are all the transitional stages from the very first attempts of organization of the blood clot between the bone ends through the stage of fibrosis and cartilage formation up to consolidated bony callus. Our knowledge of the morphology of bone repair and regeneration is too meager to enlighten us on the origin and the various stages of the development of an osteoblast. There is, however, considerable evidence tending to show that fibrous tissue, myxomatous tissue, and cartilage are definite stages through which osseous tissue may pass during its development. These definite stages are met in osteogenic sarcoma. In some, the differentiation of the tumor elements goes on to formation of fibroblasts, in others it is sidetracked to myxomatous tissue, in still others the ability of the cells to differentiate goes no further than the stage of cartilage, while in some osseous tissue is formed. The consistency of osteogenic sarcoma, however, is not

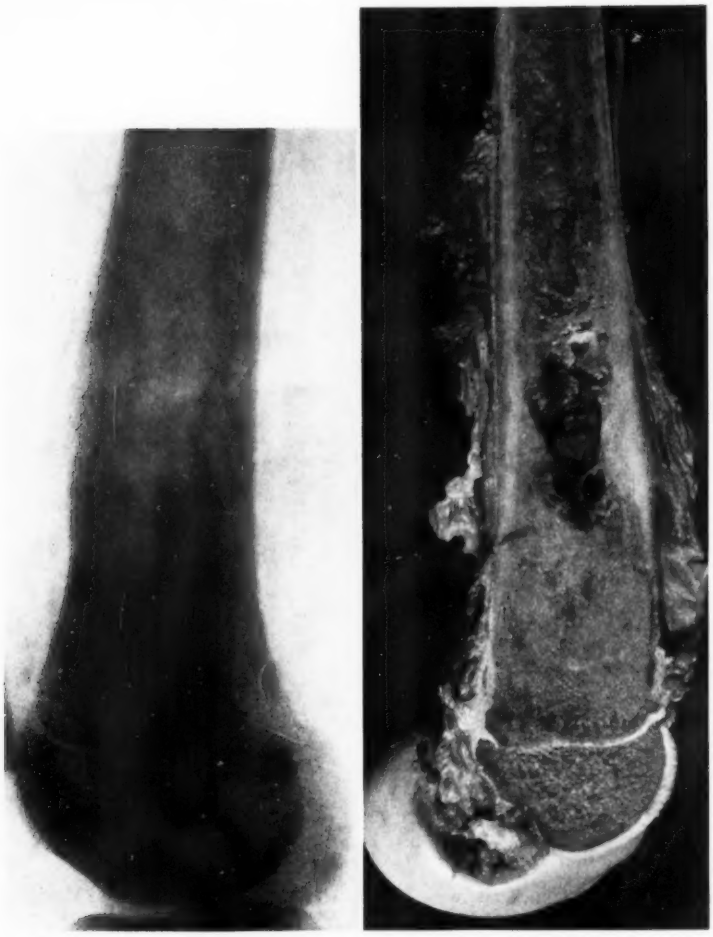


Plate 6. Case 341. Osteogenic sarcoma in a boy 15 years old. Notice the cyst in the gross specimen; a result of central degeneration of the tumor. Death 1 year and 10 months after the onset.

defined by the presence of one certain type of tissue—in the majority of cases usually two or more various tissues may be observed simultaneously.

According to the degree of differentiation of osteogenic sarcoma these tumors are usually divided in two groups: osteoblastic and osteolytic depending upon the degree of bone production or destruction. From the material studied I believe that there are no pure osteoblastic or pure osteolytic osteogenic sarcomata. The tendency of all cases of this class of sarcoma is to produce bone in

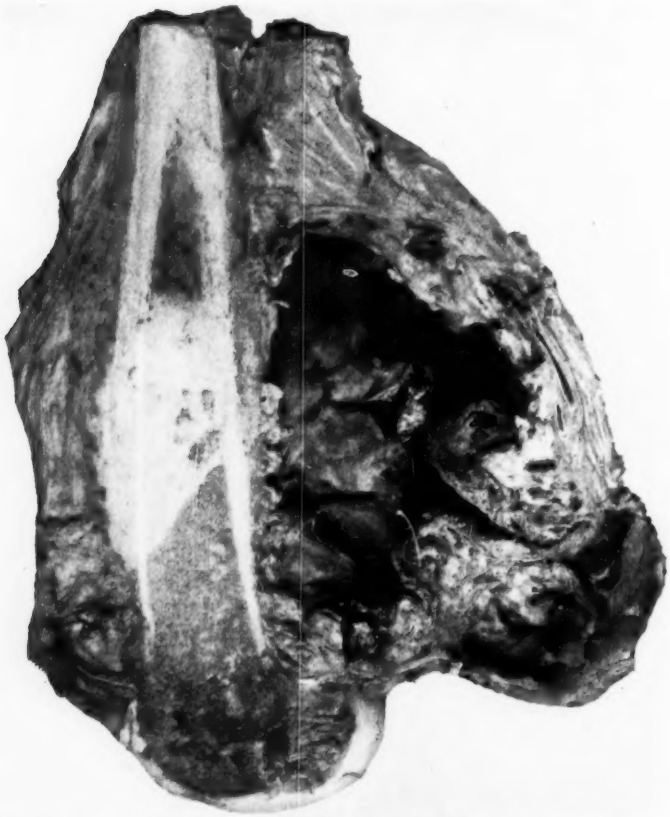


Fig. 10. Case 584. Osteogenic sarcoma in a girl 19 years old. Amputation was done after heavy radiation therapy. Notice the extensive cyst; the cyst was filled largely with necrotic tumor tissue.

some part of the tumor, because, as it was pointed out above, the cells of which an osteogenic sarcoma is composed are of the osteogenic variety. An osteolytic tumor, having destroyed much of the involved bone, usually shows minute foci of new formed bone sparsely scattered through the tumor, which when the tumor is cut give a gritty sensation. In an osteoblastic tumor we see along with masses of new formed bone, casting the characteristic dense shadow in the roentgenogram, also numerous minute foci of cellular areas without any trace of bone formation. There is, however, a decided difference in the consistency of an osteoblastic and osteolytic osteogenic sarcoma. The softness of an osteolytic osteogenic sarcoma ranges between the firm elastic consistency of cartilage and the semifluid consistency of myxomatous tissue. Besides minute foci of bone,

Fig. 11. Case 313. Skeletal chondroma. The tumor is incised and the central portion laid open. Showing extensive degeneration with cyst formation in the cartilaginous matrix.

Fig. 12. Case 462. Small spindle cell variety of osteogenic sarcoma.

osteolytic tumors are composed of cartilage, myxomatous tissue or fibrous tissue, or a combination of two or all three. The consistency is dependent upon the prevalence in the tumor of any one of these tissues.

From the standpoint of the theory of "repair and growth restraint" osteolytic osteogenic sarcomata may be regarded as tumors in which the differentiation of the cellular elements has proceeded to a certain point on the long path between the primitive mesoblast and the mature osteoblast. In relation to this two observations are interesting. One is that osteolytic tumors are much more frequent in adults than in children and adolescents; and the other is that an osteolytic osteogenic sarcoma more frequently invades the epiphysis than an osteoblastic osteogenic sarcoma. The latter fact is probably merely a result of the former—the ossified epiphyseal line in adults is not resisting to an epiphyseal invasion of a metaphyseal osteogenic sarcoma. The fact that osteolytic osteogenic sarcomata are met more frequently in adults in whom the regenerative powers of the bone are weaker than in the young seems to correspond well with the expressed idea of an osteolytic tumor being an undifferentiated osteogenic sarcoma.

The consistency of an osteogenic sarcoma with the preponderance of fibrous tissue is not very different from that of a fibroma, especially of the sclerosed

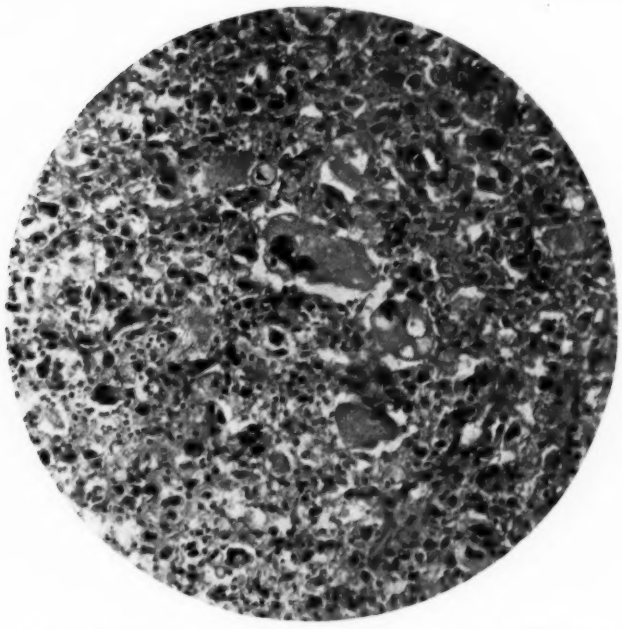


Fig. 13. Case 540. Osteogenic sarcoma. Showing the large polyhedral cells, said to be undifferentiated cartilage cells.

variety. An extensive destruction of bone with a substitution of a large fibroma is extremely rare, only two cases having been recorded in the Registry. Osteolytic tumors with prevalence of fibrous tissue are frequently located close to the medulla and this fact has been brought (Phemister) as evidence of the necessity of the recognition of "medullary fibrosarcoma" as a separate anatomical entity. The constant findings in such tumors of traces of bone formation, however, seem to contradict the rationality of a separation of these tumors from the group of osteogenic sarcoma. The clinical course and ultimate results furnish hardly any evidence of the exclusiveness of this variety of osteogenic sarcoma. Histologically a medullary fibrosarcoma is an exaggerated osteitis fibrosa in which the development of fibrous tissue is so extensive that it leads to an atrophy of the cancellous bone (Fig. 9).

When cartilage prevails in the osteolytic form, the tissue is firm, elastic, gritty, with the grayish white, semitranslucent, milky, bluish appearance of cartilage. Osteogenic sarcomata entirely consisting of myxomatous tissue are uncommon. More frequently myxomatous areas are found in tumors with an abundant admixture of cartilage. The presence of myxomatous tissue in the tumor is frequently accompanied with hæmorrhagic extravasation and this adds

Plate 7. Case 49. Osteogenic sarcoma. Showing the huge amount of chromatin in the tumor cells passing through a mitotic stage.

Fig. 14. Case 62. Osteogenic sarcoma. Showing mononuclear and polynuclear giant cells in a spindle cell stroma.

to the conspicuousness of the gross appearance of the tumor: blood clots, contrasted with soft, jelly-like, translucent, grayish-white tissue.

The fact that cellular areas can be found in definitely osteoblastic osteogenic sarcomata is of interest in relation to the idea, widely spread among bone pathologists, of a sclerosing type of osteogenic sarcoma. If true sclerosing osteogenic sarcomata do exist they are apparently a great rarity. In careful investigation of a tumor with the most pronounced dense shadow typical of sclerosing osteogenic sarcoma in the roentgenogram, cellular areas may be found with growth propensities typical of most malignant tumors. Cases have been observed in which along with a definite sclerosing character of the tumor in the roentgenogram cysts were present. It is best perhaps to draw an analogy between sclerosing osteogenic sarcoma and scirrhous carcinoma: the density of the stroma does not negate the presence of carcinomatous tissue.

The influence of the degree of vascularity of an osteogenic sarcoma on its consistency and gross anatomy is evident. In tumors with prevalence of cartilage and myxomatous tissue the blood supply is very moderate. In such cases the vessels usually run beneath the capsule of the tumor, the central portion of the tumor being poorly supplied. This is especially true of skeletal chondromata

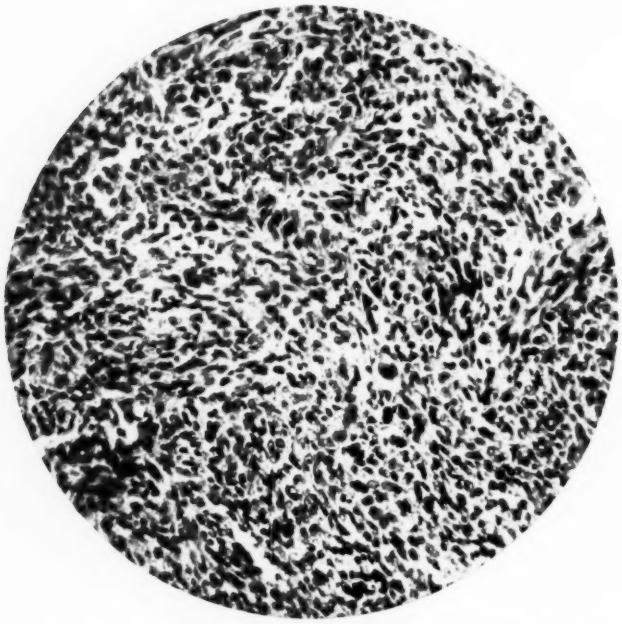


Fig. 15. Case 22. Photomicrograph of section taken from the same tumor as in Figure 16. Showing a lawless conglomeration of tumor cells; the intercellular substance is scant.

which have for many years remained benign and in which an incomplete surgical operation or trauma leads to an increase of the blood supply. Osteogenic sarcomata, which appear like such from the start, are usually very vascular; it is perhaps an analogy to the fracture-hyperæmia which is seen in young immature callus. With the further growth of the tumor the vascularity may change. It may decrease, especially in osteolytic tumors; or it may increase quantitatively and qualitatively—the number and size of the blood vessels may increase.

It has long been urged that cases with excessive vascularity be made a separate clinical and anatomical subdivision of osteogenic sarcoma. The main anatomical peculiarity of such a tumor is its rapid destruction of the involved bone. The destruction may extend along one of two ways: the shaft is simply absorbed and the whole tumor is enveloped in the periosteum with its thin bone capsule, or the shaft is rapidly perforated by the expanding tumor and is broken up in pieces. The remnants of the shaft may be found as sequestra surrounded by blood clots. The amount of tumor tissue present in such an osteogenic sarcoma varies greatly. Usually the cellular areas are quite extensive. In such cases there are no large blood spaces, but numerous small blood capillaries forming a

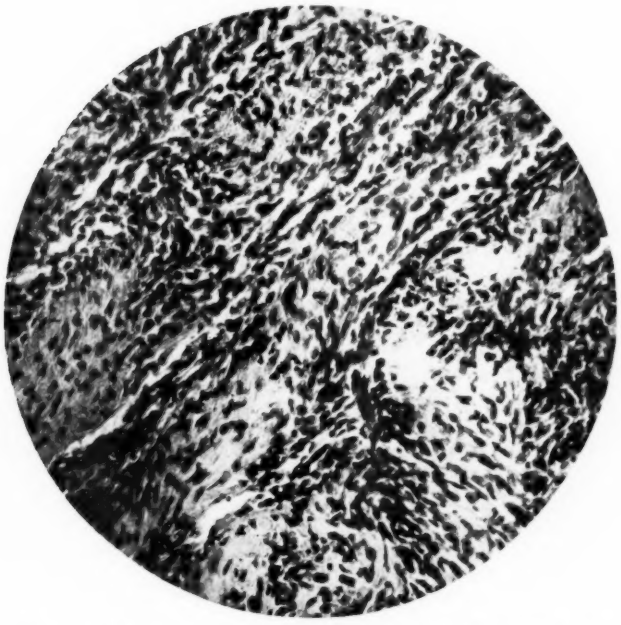


Fig. 16. Case 22. Compare with Figure 15. Osteogenic sarcoma. Showing an arrangement of the tumor cells in fasciculi; a visible amount of intercellular substance is present.

web-like net throughout the mass of tumor cells. Rarely in an osteogenic sarcoma the tumor tissue present is very limited and the entire tumor is constituted of thin walled alveoli surrounding wide blood spaces. Such tumors rapidly perforate the periosteal capsule, and then they may pulsate and even have a bruit (Plate 5). Despite the view commonly held that the telangiectatic osteogenic sarcomata give a poorer prognosis, there is no sufficient clinical evidence to bear it out. Neither clinically nor radiologically is it possible to make the diagnosis of telangiectatic osteogenic sarcoma. Only after the gross specimen is seen can such a distinction be made. The arguments for distinguishing telangiectatic osteogenic sarcomata as a separate entity are old. In 1879 Gross spoke of telangiectatic osteogenic sarcoma. His definition of this type of tumor was "sarcoma with excessive vascularity." The same definition though changed in words is still being given by all those who are urging the recognition of telangiectatic osteogenic sarcoma at this day. Vascularity alone is not sufficient to justify an exclusion of a tumor which is essentially a typical osteogenic sarcoma. It goes without saying that the definition "excessive" vascularity is very arbitrary and relative.

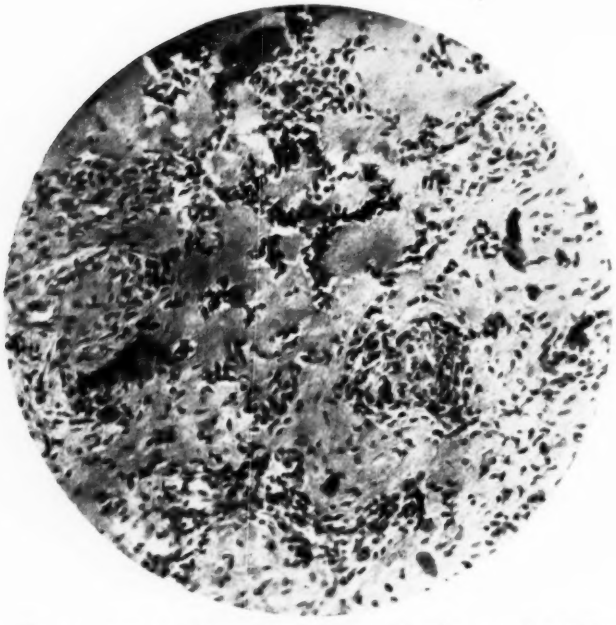


Fig. 17. Case 10. Osteogenic sarcoma. Showing a palisade-like arrangement of the tumor cells about hyaline masses.

The gross anatomical appearance of an osteogenic sarcoma may be greatly changed by regressive changes in the tumor. Because it is of importance to be able to diagnose an osteogenic sarcoma from the gross appearance, knowledge of the frequent degenerative changes occurring in these tumors is of interest. It should be kept in mind that these tumors are prone to degenerate with the result that the color may attain various shades from true fish-flesh to dark-bluish or reddish brown. The consistency may vary from that of the normally encountered resilient feel of liver to that of brain tissue, thin gelatinous substance, or even to fluid. Grossly necrotic tissue, mushy bone-marrow and even a pus-like mass mixed with bone sand are not uncommon findings. It is thought that the cause of degeneration is lack of living material in the rapidly growing tumor, but as a matter of fact degenerative changes frequently occur in very vascular tumors. Central medullary degeneration in osteogenic sarcoma may lead to cyst formation with subsequent perforation of the cortex and periosteal capsule and formation of an extensive extra-osteal tumor (Plate 6). Such tumors have been known for long as "malignant bone cysts," a loose term not in any way expressing the true nature of the tumor. It should be borne in mind by the pathologist and the clinician that radiation therapy also frequently leads to

Fig. 18. Case 537. Osteogenic sarcoma. The tumor cells are surrounded by a hyaline intercellular substance ("near osteoid substance").

extensive degenerative changes and cyst formation (Fig. 10). The regressive changes following radiation of osteogenic sarcoma are so frequent and often so extensive that they deserve more attention from the pathologist and surgeon than is usually given.

Of interest are the gross anatomical features of the so-called recurring type of skeletal chondroma. The clinical features of this not infrequent tumor will be pointed out in detail in their respective places; suffice it to mention here that these tumors are characterized by their long duration before the onset of symptoms. An apparently benign tumor remains stationary for years until an incomplete surgical operation or some other kind of intervention (trauma) leading to an increase of vascularity of the tumor takes place, when the tumor rapidly acquires the characteristics of an osteogenic sarcoma. Grossly these tumors do not seem to involve the cortex at all. However, local recurrence and later metastases and death prove the malignant nature of the tumor. The tumor frequently reaches a very large size. The tumors have apparent capsules which are intimately attached to them. On the cut section, cartilage with calcified areas is seen; this explains the grating with which the knife cuts the tumor. Degenera-

Fig. 19. Case 216. Same tumor as in Plate 11. Osteogenic sarcoma. Showing the polymorphic variety of the cells in atypical "abortive" cartilage.

tive changes with cyst formation are frequent findings in these tumors (Fig. 11). That the pathologist and surgeon are not sufficiently informed about this type of tumor is judged from the instances of erroneous prognoses given.

Structure

The histological picture of the group of tumors designated as osteogenic sarcomata is most conspicuous and varied. It would be erroneous to attempt to give a typical picture of an osteogenic sarcoma. The large majority of osteogenic sarcomata are histologically atypical, or better still there is no one type of osteogenic sarcoma. Osteogenic sarcoma is a tumor derived from cells which are descendants of mesoblastic elements predestined embryologically to form bone, hence the cellular elements of osteogenic sarcoma have the potential ability to differentiate into osteoblasts. The ladder which leads the undifferentiated mesoblast up to the culminating point of differentiation—the osteoblast—has many rungs. The theoretical potential ability of the tumor cells to differentiate expresses itself in reality not in every individual tumor to the same degree. The apex of differentiation—the osteoblast—is the final goal which can be reached

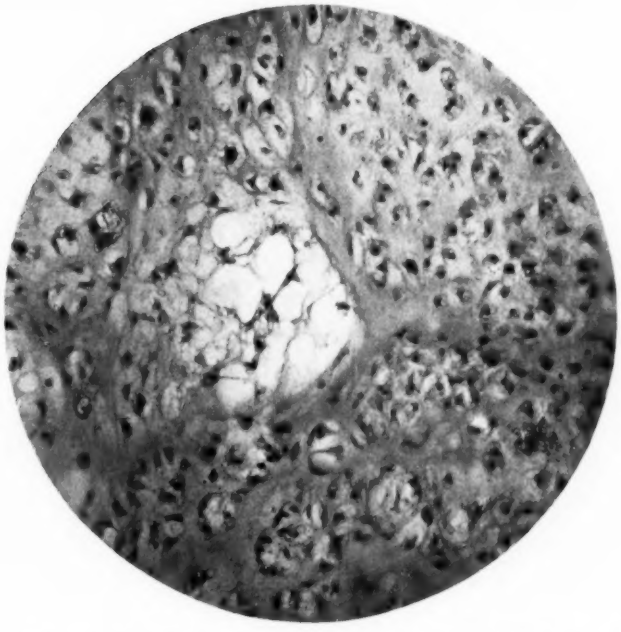


Fig. 20. Case 197. Section taken from the same tumor as in Figure 21. Osteogenic sarcoma. Showing atypical cartilaginous matrix with a beginning myxomatous degeneration.

by a tumor cell but which is not always reached. Something prevents the cell from further climbing up the ladder of differentiation and drives it to assume its lawless career. In almost every case of osteogenic sarcoma cells may be found which are arrested in their differentiation at various steps of the ladder.

It is easy to see how the numerous possible combinations of cells in various stages of differentiation lead to the many varieties of osteogenic sarcoma. The histological picture is still further complicated by the great variety of the intercellular substances. Here also several stages may be encountered in which the intercellular substances vary from simple fibrillation and hyalinization to true bone formation. The changes in the involved bone itself contribute greatly to the complexity of the histological structure of osteogenic sarcoma. The destructive and productive changes in the bone as a result of the aggression of the tumor are most complicated and interesting. Finally, the variety of the blood vessels and other peculiarities of osteogenic sarcomata emphasize the exceptional nature of their histology, as compared with other malignant tumors.

Through the collective studies of "bone sarcoma" by men associated with the Registry, it is possible today to state most definitely that two types of cells

Fig. 21. Case 197. Compare with Figure 20. The myxomatous degeneration of the cartilage is completed.

which have enjoyed a most important place in the histology of osteogenic sarcoma according to former teachings do not really belong to the structure of osteogenic sarcoma. One of these is the giant cell of epulis type. Tumors consisting mainly of this type of cells are permanently excluded from the group of "bone sarcoma." The other type of cell is the round cell. It cannot be emphasized too strongly that osteogenic sarcomata are never of the round cell type. In other words, if the leading cell of the tumor is a round cell it is not an osteogenic sarcoma. Erroneous statements on the presence of round cells in osteogenic sarcoma are frequently due to the fact that the study given the tumor was not careful enough. This is especially true when the predominating cell type is the small spindle cell. In this the nucleus is small and hyperchromatic, and the cell borders are made out with difficulty, so that on cross sections such cells will easily simulate round cells.

The most frequent cell type in osteogenic sarcoma is the spindle cell. This is not surprising when one recalls that the spindle cell is the standard type of cell participating in normal bone repair processes. The most frequently encountered spindle cell is of the small variety with a small hyperchromatic nucleus with undistinguishable cell borders (Fig. 12). When the small spindle cells

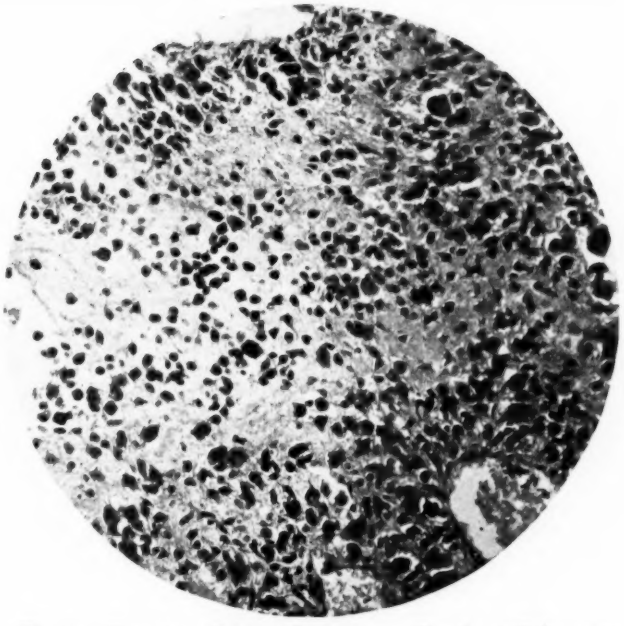


Fig. 22. Case 303. Osteogenic sarcoma. Showing cellular areas about the blood vessels and the relatively acellular cartilaginous matrix.

become larger, thicker, fuller, and plumper with bodies drawn out into filamentous processes we have the large spindle cells. With the further increase in size of the nucleus and the amount of the cytoplasm of these large spindle cells, when the filaments become detached from the cell, we have the polyhedral cells. There is very little morphological difference between such a polyhedral cell and a true bone cell. As in other rapidly growing malignant tumors one of the main characteristic features of the tumor cell is hyperchromatism. The chromatin in the nucleus—that morphological indicator of the growth propensity of the cell—is present here in large amount and causes a deep staining of the nucleus (Plate 7). It should be remembered, however, that hyperchromatism is of significance only when demonstrated in good technical hands; it is then a more important sign of malignancy than differentiation of the cells into fibers and bundles is a sign of benignity. Frequently the hyperchromatism observed is a result of old hæmatoxylin which requires a prolonged decolorization in acid alcohol. Variation in the size of the cells in the same tumor is very frequently encountered in osteogenic sarcoma. The chief feature of an osteogenic sarcoma arising in a persisting or recurring skeletal chondroma is the variation of the cartilage cells. The large polyhedral tumor cells frequent in tumors with a cartilaginous matrix

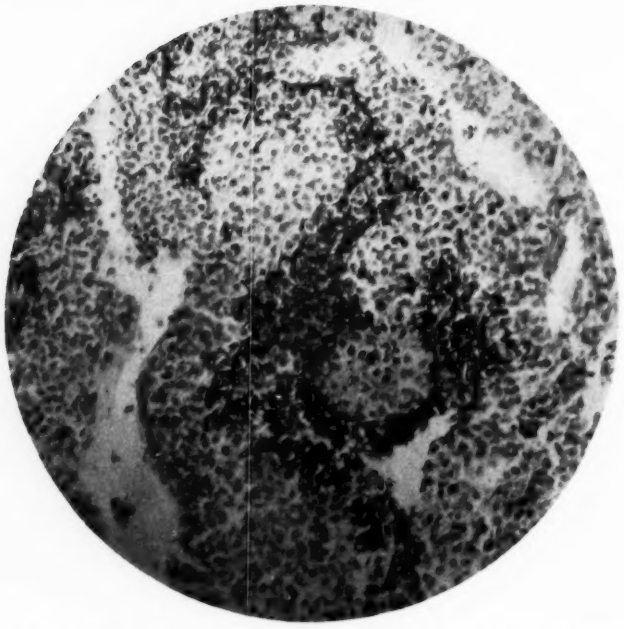


Fig. 23. Case 550. Osteogenic sarcoma. An early stage of ossification. The individual cells are surrounded by deeply staining granules marking the cell borders.

are said to originate from cartilage cells, or better, are undifferentiated cartilage cells (Fig. 13). Tumors of the great trochanter are noted for such cells.

Of much confusion has been the question of giant cells in bone tumors. Be it said at this time, and this applies to all types of bone tumors malignant and benign, that we have in the distinction between "tumor giant cells" and "giant cells of epulis type" a morphological feature of prime importance. It is not in the scope of this monograph to deal with fundamentals of general pathology with reference to histological distinction between these two kinds of giant cells. While giant cells of the epulis type may be met in most reparative processes of bone and in benign tumors and inflammatory processes, tumor giant cells are seen only in malignant tumors and especially in osteogenic sarcomata. The most frequent tumor giant cells are the so-called mononuclear giant cells, while polynuclear tumor giant cells are seen chiefly in very rapidly growing osteogenic sarcomata (Fig. 14). A warning should be inserted here as to the importance of finding of giant cells in tumors in which an exploratory operation was done previously; the benign granulation tissue in the infected operative wound in the explored tumor may easily show such findings. While not a con-

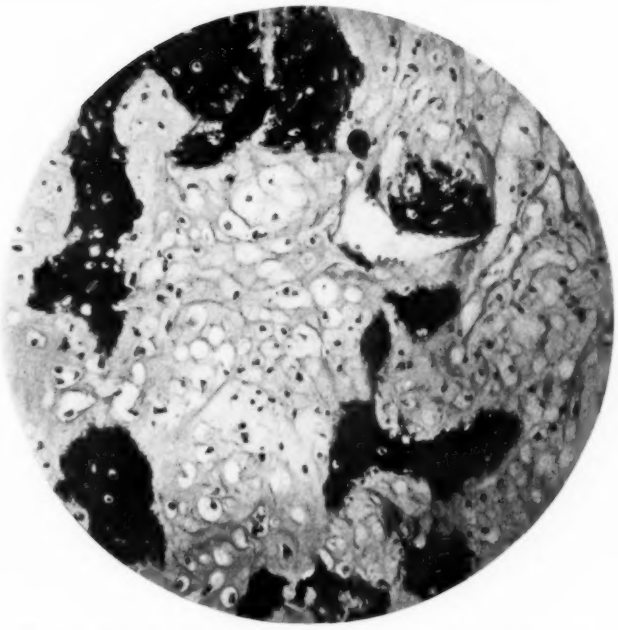


Fig. 24. Case 84. Osteogenic sarcoma. Further stage of ossification. The fusion of the granules leads to formation of bone trabeculæ.

stant finding, giant cells of epulis type are not infrequently seen in osteogenic sarcomata. Their numbers are sometimes so large as to awaken doubt in the inexperienced observer in the diagnosis of osteogenic sarcoma. In such cases a diagnosis of giant cell tumor is usually entertained. Another error is sometimes made when a tumor containing abundant giant cells and arising from tendon sheaths of fingers and toes is regarded as an osteogenic sarcoma of a phalanx. Giant cells of the epulis type are met frequently in far advanced cases of osteogenic sarcoma as a result of rapid and extensive bone absorption. These cells are not infrequent also in necrosing and suppurating areas of osteogenic sarcoma.

The chief morphological difference between osteogenic sarcoma and other malignant tumors is its intercellular substance. It is evident that with our methods of study of the intercellular substance being the same as those employed for study of the cellular elements we cannot expect to be greatly enlightened on this subject. If biochemistry is an integral part of biology, as indeed it is, it is here in the study of the intercellular substance that biochemical methods of investigation are urgently needed. Our knowledge of the intercellular substance, gained solely from morphological studies, is interesting in that it presents more clearly the whole process of development of osteogenic sarcoma.

Fig. 25. Case 273. Osteogenic sarcoma. Showing various stages of neoplastic ossification: fibrillation, hyalinization, and calcification.

All the varieties and shades of the intercellular substance encountered in osteogenic sarcoma may be grouped with one of the five types—hyaline, osteoid, cartilaginous, myxomatous, and osseous. To the hyaline type belongs not solely the hyaline homogeneous mass frequently seen in osteogenic sarcoma. The transparent sclerosed collagen fibers—the product of the filaments of the cell ends on one hand, and the homogeneous amorphous gelatinous mass on the other hand are best grouped with the pure hyaline intercellular substance. That the latter is a product of differentiation of cells normally striving toward bone production is evidenced by some interesting structural features of the tumors, especially well studied in the tumors of the spindle cell variety.

Sometimes in one and the same tumor, and always in a series of tumors, the leading tumor cell can be seen in one of four various arrangements. The first and most frequent finding is when the tumor cells form a lawless conglomeration without any visible order and without any seeming purpose of existence; the intercellular substance then is very scant and may be demonstrated only by special methods of study (Fig. 15). The next stage is when the cells evince some signs of beginning differentiation. The cells become arranged with their long axis in fasciculi, abundantly interwoven and interlaced among themselves

Fig. 26. Case 476. Osteogenic sarcoma. Showing intracartilaginous ossification in tumors with a cartilaginous matrix. Defibrillation of the matrix is followed by ossification.

(Fig. 16). They show a remarkable disposition to retain their arrangement, to which the easily demonstrable collagenous intercellular substance greatly contributes. These are the "bastard" osteoblasts. The third stage is a palisade-like arrangement of the tumor cells about hyaline masses. In cross section such groups of cells present easily distinguishable acini-like structures filled with hyaline substance readily stained with eosin light pink (Fig. 17). Further follow-up of these cells shows the last stage when the cells become surrounded by hyaline substance tending constantly to become more concentrated and by this time to show unmistakable signs of calcification (Fig. 18). The hyaline intercellular substance is a "near osteoid" substance from which the true osteoid matrix may form. In some cases of osteogenic sarcoma the less matured form of "near osteoid" substance prevails—a homogeneous amorphous gelatinous substance which is frequently erroneously interpreted as œdema of the tumor. "Near osteoid" substance is not an exclusive attribute of osteoblastic osteogenic sarcoma; it is not infrequently found in radiologically true osteolytic osteogenic sarcoma, an additional argument against attempts to make osteolytic tumors, mainly the medullary fibrosarcoma an entity distinct from osteogenic sarcoma.

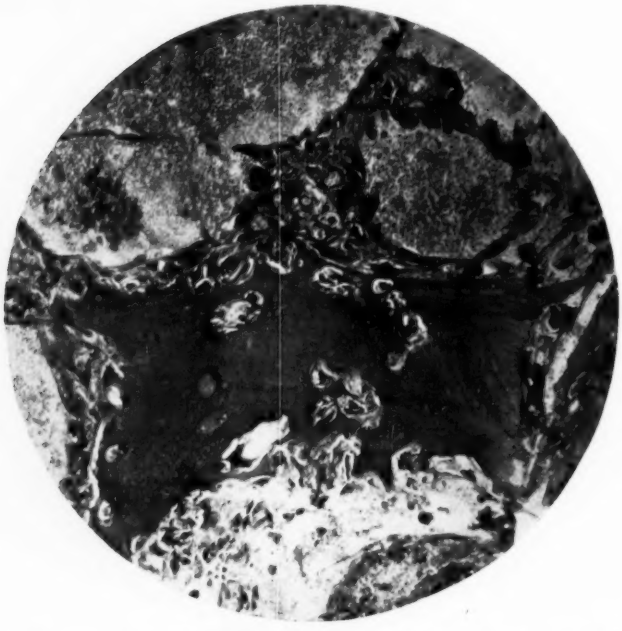


Fig. 27. Case 483. Illustrating the various modes of bone destruction in osteogenic sarcoma: bone destruction due to peripheral absorption, to vascular pressure, and to canalization by tumor cells.

When the hyaline matrix is abundant from the onset, it usually contains cartilage cells of varied size and shape; the ovoid and fusiform cartilage cell spaces contain one or more cartilage cells, mostly without capsule (Fig. 19). This is an abortive kind of cartilage when the pleomorphic character of the cells is the main sign of malignancy. Myxomatous tissue in osteogenic sarcoma is usually seen merely as a phase in tumors with an atypical cartilaginous matrix preponderating (Figs. 20 and 21). An intermingling of various types of intercellular substance in the same tumor is not uncommon in osteogenic sarcoma. The fact that all the tumor cells in the same tumor do not reach the same degree of differentiation at a given time easily explains why the same tumor produces condensation in the roentgenogram in one area and rarification of the shadow in another. The product of the cells of the same tumor may be osteoblastic, chondroblastic, and fibroblastic.

In osteogenic sarcoma with a preponderating relatively acellular cartilaginous matrix cellular areas may be seen closely surrounding vascular channels and spaces. These channels, usually blood capillaries, are in the center of the cellular areas while farther to the periphery avascular abortive cartilage is seen (Fig. 22).

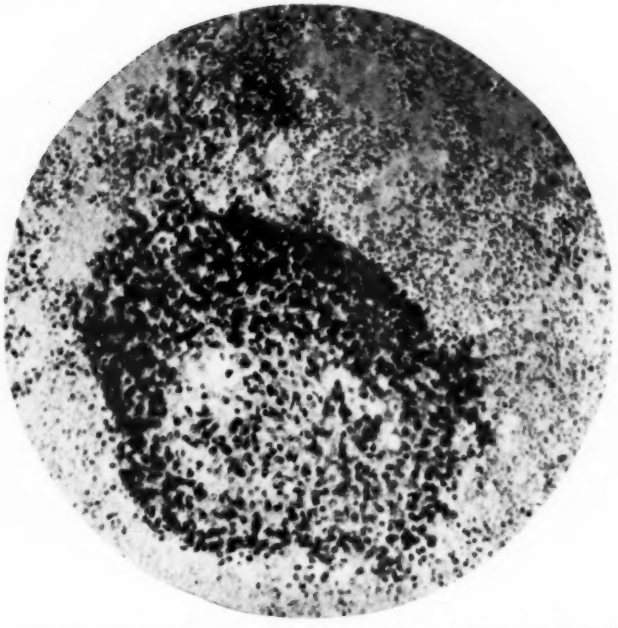


Fig. 28. Case 98. Same case as in Plate 5. "Telangiectatic" osteogenic sarcoma. Showing an island of tumor tissue loose in a blood space.

Whether these are conglomerations of tumor cells merely as a result of the proximity of a nourishment supply (vascular space), or whether the vessel is secondary to the accumulation of cells in one area, is a matter of speculation. In this connection it is interesting to note that the most frequent regressive changes in cartilage cells are the hydropic changes which are probably due to a discharge of water by the cell with precipitation following in it of water soluble constituents.

Some tumors which previously were believed to originate from periosteum, evince a remarkable disposition to ossification of their intercellular substance. They are sometimes known under the confusing name of osteoid sarcoma. These firm or soft medullary, brain-like, semifluid, or gelatinous tumors are traversed by numerous dense glistening striæ which are closely aggregated at their base on the bone surface. These spicules are mostly arranged perpendicularly to the surface of the involved bone; occasionally they pursue a course parallel to the periosteum raised from the bone by the expanding tumor. The fact that this parallel striation, although infrequent, does occur in osteogenic sarcoma, was entirely neglected by previous investigators.

The best explanation of the radiating striation in some osteogenic sarcomata is furnished by topographic-microscopical studies of such tumors. Microscopi-

Fig. 29. Case 393. Osteogenic sarcoma. Showing the perithelial arrangement of tumor cells. The cells are in intimate proximity to the endothelium of the thin walled capillaries.

cally one sees dainty spicules attached by a relatively broad base to the cortex of the bone running perpendicularly to the elevated periosteum with its thin bone shell forming the investing capsule of the tumor. After approaching the periosteal bone shell, the spicule changes its course to one parallel with the periosteal bone trabeculæ, finally merging with the latter. The perpendicular striæ are connected among themselves by means of jagged, short, lateral ramifications. The striæ and their ramifications consist of osteoid or true osseous tissue. Tumor masses with thin walled blood vessels running parallel to the perpendicular striæ fill up the spaces between the spicules. From serial sections one gets the impression that the perpendicular blood capillaries emerge from the haversian system of the involved bone. When the periosteum is slowly being pushed away from the underlying bone by the expanding tumor the periosteal blood vessels entering into and arising from the haversian system are stretched in the direction perpendicular to the bone. Apparently the course of the blood capillaries defines the lines along which the osteoid tissue formation and ossification is to take place. That the blood vessels do play an important rôle in the arrangement of the striæ is suggested also by the fact that when the tumor perforates the investing perios-

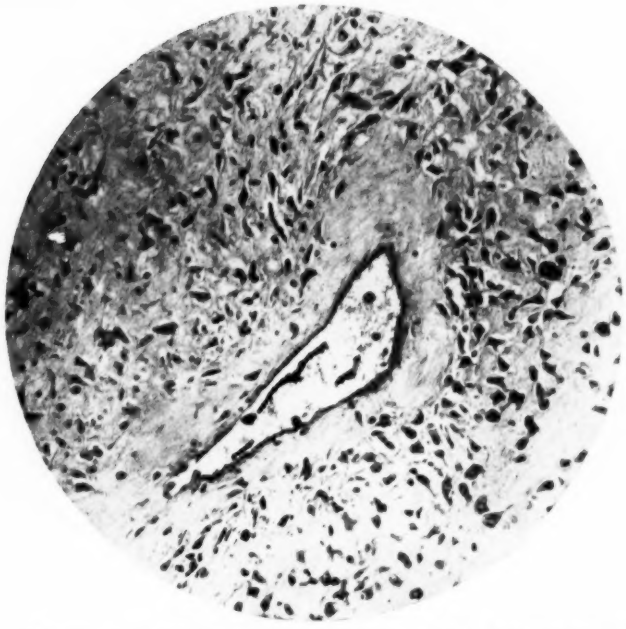


Fig. 30. Case 317. Osteogenic sarcoma. Showing a blood vessel lined by endothelium with a wall consisting of a homogeneous mass suggesting an osteoid or near osteoid substance.

teal capsule and becomes extra-osteal the radiating arrangement is mostly missing in the extra-osteal portion of the tumor with its disorderly arranged blood vessels.

Ossification of the intercellular substance in osteogenic sarcoma is the apex of differentiation which may be reached by the tumor cells and intercellular substance. The whole biological process of ossification is immensely complex and our knowledge of it at present is far from complete or satisfactory. Like normal ossification in the animal body, ossification in osteogenic sarcoma is known to us mainly in its morphological features which certainly are less important than the biological and microchemical features of this process. It is the degree of ossification in osteogenic sarcoma that draws the line between osteoblastic and osteolytic forms. After all, the whole difference is probably a chemical one; that it is not anatomical one sees from the rapid ossification which frequently sets in in an osteolytic osteogenic sarcoma after radiation.

According to morphological findings one meets in osteogenic sarcoma with two types of ossification—the metaplastic and neoplastic. When under certain favorable conditions, of the nature of which nothing is known today, an organic component added to the pre-existing fibrillar intercellular substance leads to

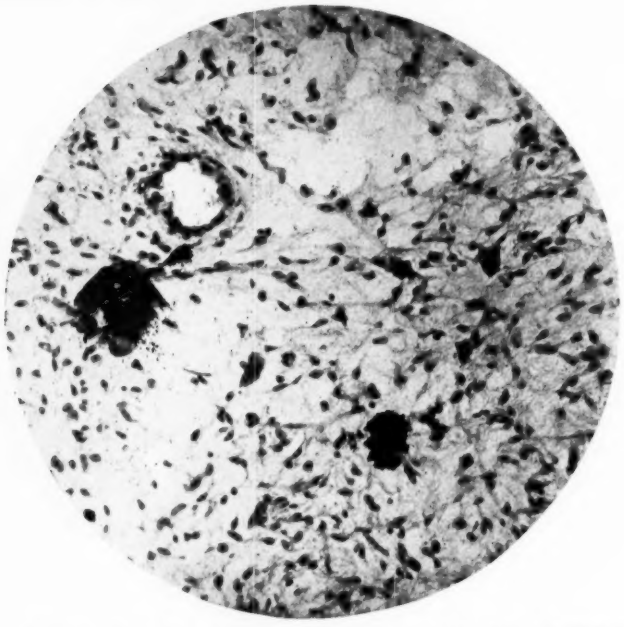


Fig. 31. Case 360. Osteogenic sarcoma. A blood vessel with a wall consisting of a myxomatous substance is seen.

homogenization and hyalinization of it with further calcification taking place, we have osseous tissue formed in the metaplastic way. The successive stages of the development of metaplastic osseous tissue is best studied on small islands of osseous tissue where the process of this form of ossification is in its very early stages. In sections through such areas in tissue undergoing metaplastic ossification one sees about the spindle cells embedded in a homogeneous intercellular substance numerous small cocci- and bacilli-like granules staining with hæmatoxylin deeply blue and with Van Gieson red. The granules are more numerous along the cell borders and decrease in numbers further to the periphery, disappearing entirely at some distance from the cell borders. One sees a picture resembling numerous small magnetic fields of influence with the cells in the centers (Fig. 23). At a later stage the granules continue to multiply and to join each other and soon the whole field is covered by a mass deeply blue in color with pale bone lacunæ occupied by the bone cells (Fig. 24). A certain constant relationship between this granulation and the blood capillaries can be made out. The blood vessels form the centers wherefrom the granules spread continuously. However, the immediate surroundings of the blood vessels are always free of granules even in the final stage of confluence of the granules and bone formation.

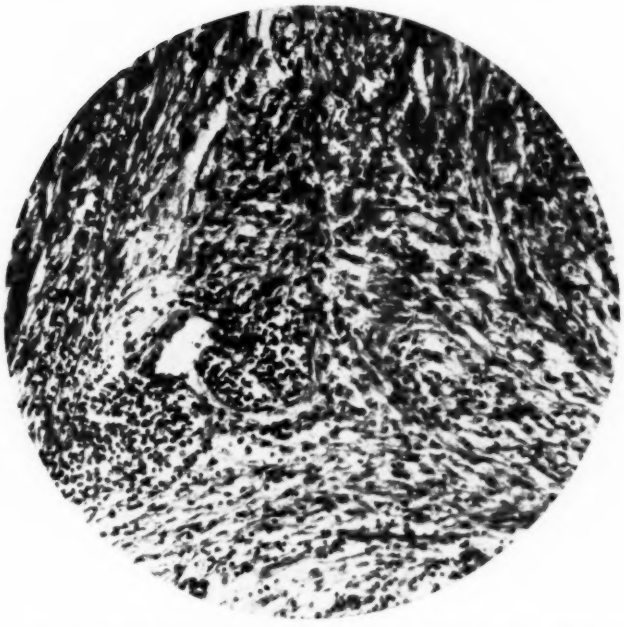


Fig. 32. Case 100. Showing a focal lymphocytic infiltration of an osteogenic sarcoma. (A 5 years' cure after amputation.)

That these granules are not precipitated calcium may be concluded from the fact that they are present in the sections after complete decalcification of the tissue. Seemingly the granules belong to the organic substances which are to be added to the pre-existing fibrillar intercellular substance for the process of metaplastic bone formation. The dependence of the granules upon the cells which they surround is seen from the fact that their number decreases with the increase of the distance from the cell. This would suggest that the granules are a product of a biological function of the cell; a function which appears in the cell as a result of some other biochemical process entirely unknown today.

The neoplastic ossification differs from the metaplastic chiefly in that in the former the fibrillar base for ossification is not pre-existing but is formed in the process of ossification by way of cell proliferation. Focal proliferation of spindle tumor cells, arrangement in rows with fibrillation and hyalinization and finally calcification are the main stages of neoplastic ossification in osteogenic sarcoma (Fig. 25). To the neoplastic ossification belongs also the not infrequent intracartilaginous ossification in osteogenic sarcoma with a rich cartilaginous matrix. The cartilage cells arrange themselves in columns separated by bundles of homogeneous fibrils invading the cartilage from the adjoining osteoid tissue

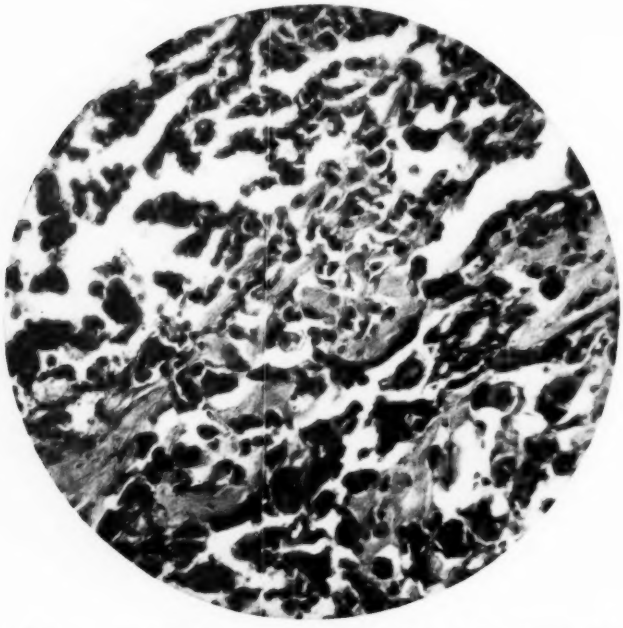


Fig. 33. Case 378. Showing hyalinization of the stroma of a lymph node metastatically involved in osteogenic sarcoma.

(Fig. 26). This defibrillation of the cartilaginous matrix precedes final ossification. In sections one frequently sees small cartilage islands surrounded by recently ossified tissue. In the course of time the remnants undergo the same fate while the older ossified portions slowly change their deeply blue color to a rose pink.

It would be erroneous to believe that it is always possible to draw a strict line between metaplastic and neoplastic ossification in general and especially in osteogenic sarcoma. It is not surprising to find in osteogenic sarcoma, that most perplexing malignant tumor of the human organism, not merely combinations between metaplastic and neoplastic ossification but also instances in which one can hardly decide where the neoplastic process stops and the metaplastic begins. After all, both these terms neoplastic and metaplastic are based merely upon morphological and not biochemical data.

Great importance has been ascribed to the discrimination in osteogenic sarcoma between bone formed by the tumor elements and that formed by the involved bone proper. In the literature and in the discussions on the Registry classification one finds the first referred to as tumor bone as contrasted with the latter as normal bone or reactive bone, i.e., bone formed as a result of a reactive

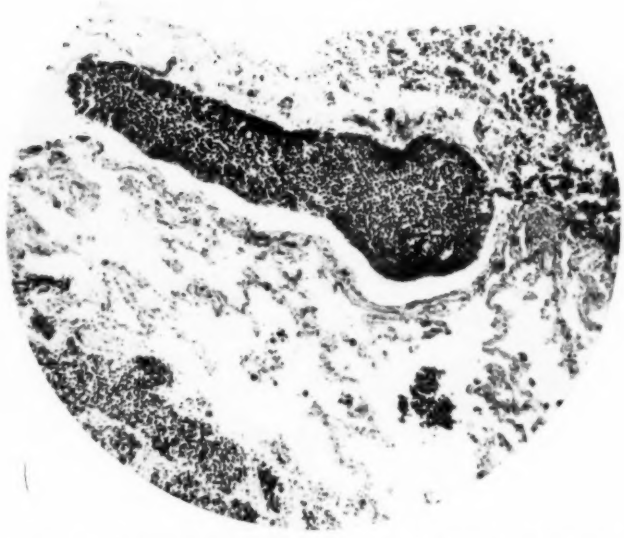


Fig. 34. Personal observation; case not registered. Pulmonary metastases in osteogenic sarcoma. Showing small nodules of tumor beneath the visceral pleura.

inflammatory process of the involved bone due to the presence of the tumor. There can be no two opinions about the fact that reactive bone as such does exist; it is a result of a proliferative reactive inflammatory process in the bone as a response to the involvement; on the other hand the whole discussion about tumor bone and reactive bone does not seem to be backed by morphological or biological evidence. The crux of the argument concerns the presence of two kinds of new formed bone in an osteogenic sarcoma—lamellary bone and trabeculated. Under lamellary bone one understands bone composed of parallel lamellæ supplied with typical bone cells inclosed in bone lacunæ. This is the characteristic structure of the physiologically normal bone. The trabeculated type of new formed bone shows irregular, mostly homogeneous or fibrillar osseous trabeculæ, staining deeply blue with hæmatoxylin, usually lacking the lamellary structure. For long the general belief was that tumor bone is always trabeculated as contrasted with reactive bone which is always lamellary. This discrimination against trabeculated bone apparently is founded on the erroneous statement of Kaufmann many years ago, which identified lamellary bone with bone produced by osteoblasts (*osteoblasten Knochen*). That reactive new bone may be

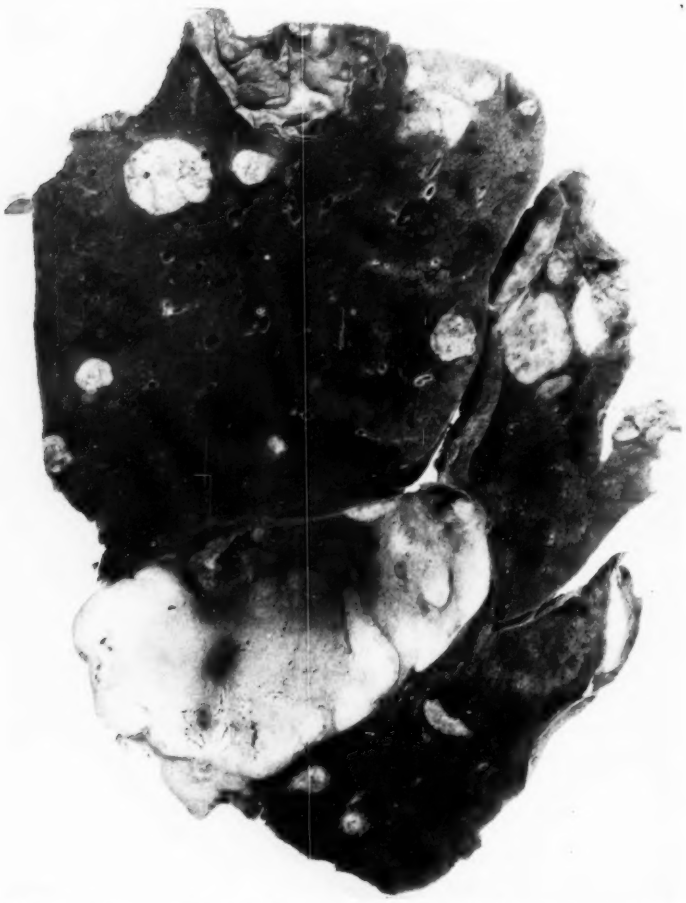


Fig. 35. Case 457. Osteogenic sarcoma. Advanced pulmonary metastases.

trabeculated we see in new bone formation in metastatic carcinoma, all the new formed bone being reactive bone and not tumor bone. Trabeculated bone is frequently seen also at some stage or other of callus formation in the process of normal fracture healing. On the other hand I have seen cases of osteogenic sarcoma in which areas of bone formation in the pulmonary metastases could well serve as illustration of normal lamellary structure of bone. Apparently the age of bone has much to do with the lamellation; in the slowly developing bone in pulmonary metastases there is ample time for the lamellary structure to take place, while in the very active process of callus formation much bone remains for a time trabeculated. It is not to be understood that in my opinion tumor

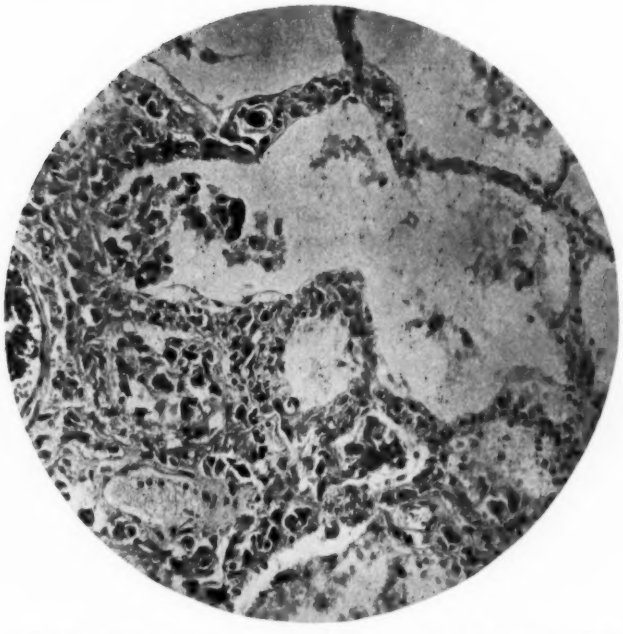


Fig. 36. Case 610. Same case as in Figures 37 and 38. Osteogenic sarcoma. Showing pulmonary interalveolar capillaries stuffed with tumor cells.

bone and reactive bone are entirely identical in every way; it is my belief that with the present day meager knowledge of the ossification process and the inadequacy of purely morphological studies of ready formed bone there is no dependable way to distinguish between tumor bone and reactive bone.

In general there is no essential demonstrable difference in the morphology between the normal physiological apposition of bone and the reactive or defensive production of bone. It was thought erroneously that the new bone is formed from the old. This conclusion is based upon the fact that wherever formation of new bone is following closely absorption of trabeculæ of the old bone, the new bone is seen closely attached to the old surrounding it. A distinction between the old and new formed bone is best reached after staining with hæmatoxylin—the old is red and the new is blue. In cases with very active new bone formation one can frequently find large groups of numerous osteoblasts—"osteoblast reserves" still unarranged but ready to defend the bone against the tumor. These polyhedral cells with relatively large nuclei appear suspicious to the inexperienced, and diagnoses of malignancy in giant cell tumors after radiation have been based upon the presence of such groups of cells along the regenerating bony capsule.

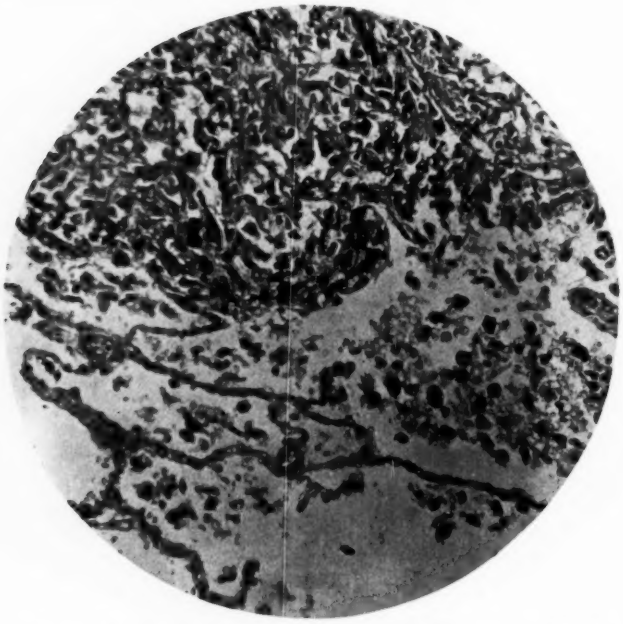


Fig. 37. Case 610. Compare with Figures 36 and 38. Pulmonary metastases with alveoli filled with tumor cells; the alveolar texture of the lung is obscured.

The inelasticity of the normal bone would prevent the growth and expansion of an osteogenic sarcoma if it were not for the destructive process exerted by the tumor upon the involved bone. The absorption of bone under the aggression of an osteogenic sarcoma is accomplished in several ways. One way is the lacunary absorption of the bone; this is the way occurring in the normal process of bone resorption. In osteogenic sarcoma, however, the lacunæ are more flat and small than in normal absorption. This difference is due to the fact that instead of large osteoclasts the tumor cells are found in the lacunæ. That the tumor cells are capable of absorption of normal bone is not at all peculiar to sarcomatous cells; in certain inflammatory conditions one frequently encounters absorption of bone without the typical osteoclasts. Typical polynuclear osteoclasts are usually seen when the destruction of bone proceeds slowly. Absorption may proceed simultaneously from the periphery and from the center of bone trabeculæ. The osteoclasts in the central area are tumor cells which have reached their place by way of newly formed canals as pointed out later. Another means of bone destruction in osteogenic sarcoma is canalization of the bone by advancing blood vessels. These are the Volkmann's canals existing in normal bone but

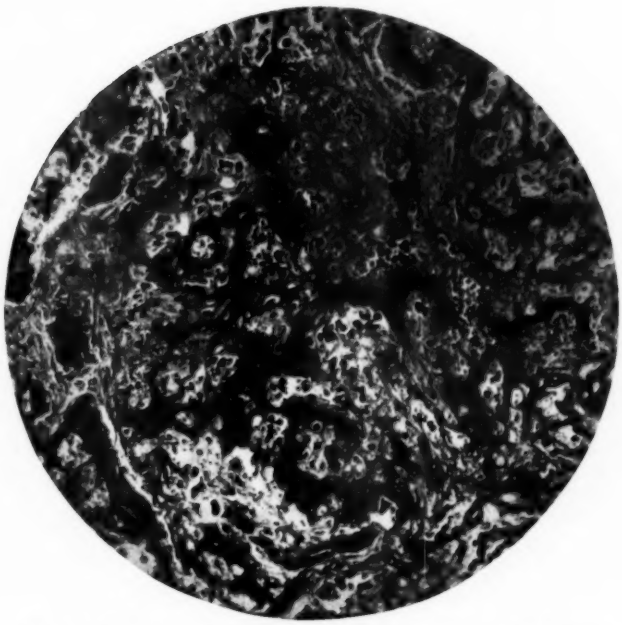


Fig. 38. Case 610. Compare with Figures 36 and 37. Pulmonary metastases with bone formation.

more numerous in a bone involved by an osteogenic sarcoma. Destruction of bone is also a result of an extreme vascularization of the tumor mass. Direct pressure of the numerous pulsating blood channels on their bony capsule leads to a rapid destruction of the bone. This explains the rapid destruction and not infrequent sequestration of large portions of the involved shaft in very vascular, so-called telangiectatic osteogenic sarcoma. Similar to bone destruction by canalization with blood vessels is that by canalization with columns of tumor cells. Through such new formed canals as well as through numerous new and old blood vessels and through the normal haversian system tumor cells cause minute communications between the medullary cavity and the subperiosteal space, leaving an apparently grossly intact shaft. By all these means the tumor gains ground and space in the involved bone (Fig. 27). The bone cells, released from their seclusion in the bone lacunæ after absorption of the bone do not seem to play any active rôle in the pathological process.

The peculiarities of the vascular system constitute one of the characteristic features of osteogenic sarcoma. In the first place the richness in vessels of an osteogenic sarcoma is interesting. These neoplasms are far better supplied with blood channels than normal bone. The only exception is found in osteogenic

Fig. 39. Case 335. Showing metastases of osteogenic sarcoma to the skin; ossification about a hair follicle is seen.

sarcoma with a pure cartilaginous matrix as a base. The excess of vascularity may be seen also in the structures close to the tumor capsule where numerous, large blood vessels are seen. There was occasion to mention above the probable increase in malignancy of an extremely vascular osteogenic sarcoma. A telangiectatic osteogenic sarcoma is not more malignant because this is an essentially different disease but merely because abundant vascularity is a sign of lack of differentiation of the tumor growth, and as such it is a direct sign of greater malignancy. This suggestion is also supported by the fact that the blood vessels are the centers of very loose cellular areas (Fig. 28). The stage of differentiation is the higher the further the given area is from a blood vessel. This is also true of certain other skeletal dystrophies: sclerosis and ossification are usually at some distance from blood vessels. Calcification is apparently slowed down by the presence of blood vessels.

The blood vessels in osteogenic sarcoma are conspicuous in their anatomical structure and in their relationship to the tumor tissue. In the average pleomorphocellular osteogenic sarcoma numerous blood capillaries may be seen coursing along clefts between tumor cells. The tumor cells seem to carry the function of the endothelial lining of these blood channels. The same relation to the tumor

may be frequently noticed in blood vessels of larger caliber. Areas can be seen where cells of exactly the same morphological structure and appearance are lining blood vessels in one field and are indulging in bone formation in another. In still other places the endothelial lining of blood vessels seems normal but the wall consists of a homogeneous mass exactly like osteoid or near osteoid tissue (Figs. 29, 30). It is also not uncommon to find a cartilaginous matrix in place of the homogeneous mass forming the wall of the blood channel (Fig. 31). The lining of a capillary with tumor cells raises the question of the origin of such a capillary. If the capillaries here are formed according to general histological rules then they are formed by sprouting of a column of tumor cells, in other words there must be a most intimate relationship between normal endothelial cells and the tumor cells. These peculiarities of the blood vessels encountered in osteogenic sarcoma have been especially emphasized by Codman, who suggests for these the term "tumor blood vessels." Codman sees in these peculiarities a proof to his statement that the malignancy of bone sarcoma lies not in a certain kind of tumor cells but in the intimacy of the cells to the blood vessels. He suggests the idea that all osteogenic sarcomata are endotheliomata because, he thinks, the tumor cells spring from blood vessels as leaves from a tree. Whatever one's opinion may be, about Codman's broad statement, there is probably more truth than error in a belief that the malignant impulse imparted to the cells of a sarcoma lies much further back than in the origin of a "malignant set of cells." It may reside in a disorder of the laws of growth.

A peculiarity in the histology of osteogenic sarcoma which deserves special emphasis is a spontaneous lymphocytic infiltration (Fig. 32). A lymphocytic infiltration is not uncommon in tumors after radiation therapy. It is also frequent in osteogenic sarcoma in which an exploratory incision was made previously; it then being a simple inflammatory reaction to the infection brought in during the operation. A spontaneous lymphocytic infiltration however is not frequent; it is met with in about 5 per cent of all cases. That the lymphocytes are not an integral part of the tumor one can conclude from the fact that they are usually found on the periphery of the tumor. In the 17 cases with a five years' cure of primary malignant bone tumors registered, the majority of osteogenic sarcomata showed a marked lymphocytic infiltration, although several of these have had previous operations. This fact raises the question whether the lymphocytic infiltration is not an equivalent of the feature encountered in early carcinoma as pointed out by Paltauf. The latter called attention to the fact that in early carcinoma there may be found a lymphocytic infiltration of the surrounding connective tissue, which according to him is a result of the reaction of the organism to the carcinomatous involvement. The same feature may be evinced by early metastatic carcinomatous involvement of regional lymph nodes while in similar involvement of an advanced carcinoma this reactive process is

absent. "Unwillingly one gains an impression that the organism has lost its resistance and the carcinomatous cells gained the upper hand." Ewing suggested the advisability of a separation of all cases of osteogenic sarcoma with a lymphocytic infiltration from the general group. However, not all cases with a lymphocytic infiltration in the Registry gave a five years' cure.

The remarkably high malignancy of osteogenic sarcoma is due to a generalization of the tumor by way of metastatic deposits in other organs. No rules can be made as to the localization of the secondary tumor growths. They are known to occur in organs of the abdominal cavity, in the brain, in other bones and even in the skin; but the most frequent, the classical seat of a metastatic osteogenic sarcoma is the lungs. Death from the development of pulmonary metastases is the outcome in a very large majority of cases of osteogenic sarcoma. A metastatic involvement of the regional lymph nodes is rare. Frequently it is difficult to decide from the section alone whether the lymph node does show a metastatic involvement; occasionally an extensive hyalinization of the stroma of the enlarged lymph node is the only sign of a metastatic involvement (Fig. 33). The metastatic growth usually shows a tendency to turn to a less differentiated and more cellular structure than in the primary tumor. On the other hand in anaplastic metastases most complex pleomorphic tumors may become simple. Usually the cells of the secondary growth may reach all the various stages of differentiation as seen in the primary tumor and it is not unusual to find a metastatic growth with all the varieties of structure of an osteogenic sarcoma.

Pulmonary metastases have a tendency to grow slowly. Cases are known in which the haversian canals of the bone found in pulmonary metastases contained a structure strongly suggesting bone-marrow. A study of a lung involved metastatically in osteogenic sarcoma may show all the successive stages of the development of the metastatic growths. The first localization of the metastases is in the subpleural portion of the lung (Fig. 34). Here, right beneath the pleura, can be seen later the typical grayish-white rounded nodules of various size and of a consistency ranging from that of brain tissue to a solid, hard, ivory-like mass (Fig. 35). The tumor cells brought in the blood stream are retained in the interalveolar capillaries of the lungs (Fig. 36). In section one sees capillaries completely stuffed with tumor cells. Soon the tumor cells break through the wall of the capillary and begin to infiltrate the alveoli. The alveoli are seen packed with tumor cells (Fig. 37). Then the interalveolar capillaries become obliterated, and it is with difficulty that one makes out the alveolar texture. The whole area is converted into a tumor mass, with very faint traces of former alveolar structure of the lung. At a later stage bone may form throughout the mass (Fig. 38). A compensatory emphysematous dilatation of the adjoining alveoli completes the picture. Although uncommon, metastases to the skin with bone formation are known to occur (Fig. 39).

Clinical Course

A study of the clinical course of the primary malignant bone tumors has always attracted much less attention than the morbid pathology of these tumors. The explanation of this probably rests with the fact that the clinician was and still is helpless when confronted with primary malignant bone tumors. Even today the average clinician will gladly shift the task of diagnosis in such a condition to the roentgenologist and pathologist. A great deal of confusion in our knowledge of the clinical course was brought in by those who in their earnest attempts to give a description of the clinical course of these conditions have dealt with the primary malignant bone tumors as a whole, that is, as with a single clinical entity. Not less harm has been added by individual reports of single cases which erroneously were considered as "bone sarcoma." Clinical histories are not always properly taken in these conditions and the clinician does not pay sufficient attention to the history in the diagnosis. A complete, well taken clinical history very frequently can decide the question of the diagnosis in cases histologically obscure. Often from a good clinical history and roentgenograms one can be as sure of a diagnosis as from seeing the patient, the lesion, the gross specimen and numerous sections.

The incidence of primary malignant bone tumors is best seen from the fact that about one case out of three of sarcoma of the human body is a "bone sarcoma," the next in frequency being lymphosarcoma. From a careful survey in the State of Massachusetts, which, due to the influence of Dr. Codman, is the best educated in registering its cases of "bone sarcoma," it is estimated that the clinical incidence of "bone sarcoma" is about one to 100,000 of population at any one moment. According to recent estimates of English observers, there is in England about one case of bone sarcoma to 75,000 of population. Judging from the data of the Registry there occur about twice as many primary malignant bone tumors as benign giant cell tumors. According to these calculations there are about 1,100 to 1,450 patients with "bone sarcoma" alive at any one time in the United States. Allowing about one-third of this number for the benign giant cell tumor and considering the average life of a patient with a true malignant bone tumor to be 5 years, we have about thirty thousand deaths from sarcoma in a generation (60 years), deaths in individuals mostly in the prime of life.

Social conditions have no influence as an etiological factor and cases of this disease are found in all walks of life. Of no great influence also seems to be sex, although the male sex is predominating in osteogenic sarcoma, the relation being about 3:4. In the first decade, however, the female sex distinctly predominates in frequency.

Osteogenic sarcoma is primarily a disease of the young. The Registry material upon which the adjoining curve is based shows that while there is no age entirely

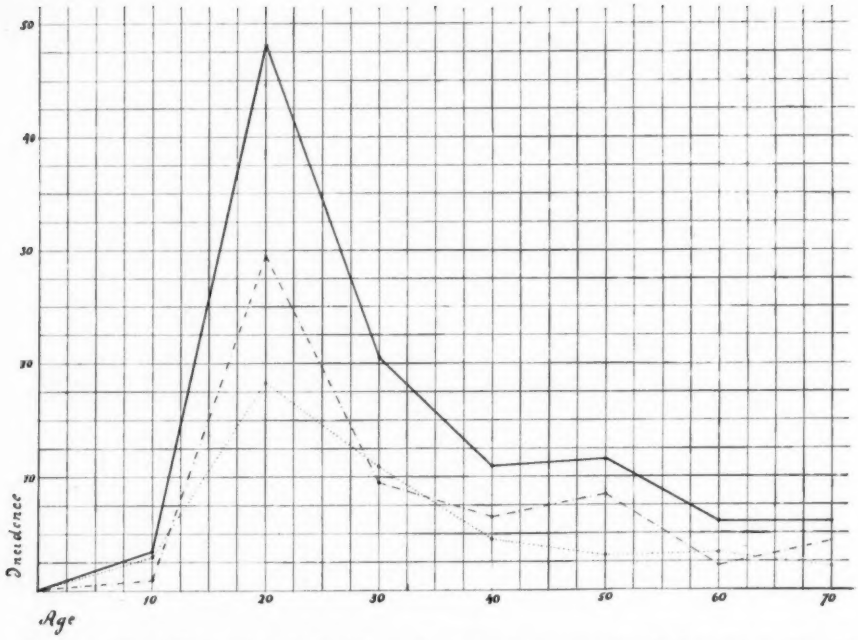


Fig. 40. Chart illustrating the incidence of osteogenic sarcoma in relation to age. Dotted line—females; broken line—males; heavy line—both sexes combined.

immune, the incidence of this tumor, however, predominates in the second decade of human life (Fig. 40). It is of the least frequency in the first decade, especially during the first few years of life. There is no authentic case on record of a congenital osteogenic sarcoma, the great majority of congenital sarcomata being located in the soft parts occasionally attached to the outer layer of the periosteum. The fact that osteogenic sarcoma develops most frequently during the period of the most energetic skeletal growth and the period of skeletal puberty has long been the basis for the inclusion theories of tumor origin and of theories of endocrine influences. The fact that the greatest frequency of osteogenic sarcoma is in the age of most active skeletal growth and development would certainly seem to indicate that energetic growth of the skeleton is one of the main factors in the etiology of these tumors.

While most bones of the skeleton may be the seat of osteogenic sarcoma they are, however, met especially frequently in the long bones. The metaphyses of the long bones are the seat of predilection of osteogenic sarcoma. This is especially marked in osteogenic sarcoma of the lower extremity which comprises about 72 per cent of all cases of osteogenic sarcoma; in 82 per cent of all osteogenic sarcomata of the lower extremity the tumor affects the region about the knee whether

it be the femur or the tibia. The relative frequency of osteogenic sarcoma in the upper and lower extremity may be expressed by the ratio 2:11; the tumors of the upper extremity comprising about 10.5 per cent of all cases of osteogenic sarcoma, and the relation between the extremities on the right and left side by the ratio 5:4. The individual bones of the skeleton with the highest frequency of involvement are the femur, tibia, humerus, all bones of the pelvis combined, the fibula, the bones of the shoulder girdle, the ulna, the bones of the hands and feet (exclusive of the phalanges of fingers and toes), the ribs, the skull, the jaws and the vertebræ. While the lower end of the radius is a common seat of giant cell tumor no authentic case of osteogenic sarcoma of this bone is known to the Registry, only two doubtful cases of osteogenic sarcoma having been recorded. The same is true of the lower end of the tibia, an homologous bone.

The bone most frequently involved in osteogenic sarcoma, the femur with its 52 per cent of all cases, has its seat of predilection in the lower metaphysis and in 82 per cent of all cases in the femur the tumor is situated in this region. The remaining 18 per cent are distributed in the shaft, about the great trochanter and in the neck. It is important to remember that about 9 per cent of all cases in the femur are located in the shaft of the bone without any gross involvement of either end. This is especially interesting since it is usually considered that an involvement of the shaft is pathognomonic of Ewing's sarcoma, and in several of the cases of involvement of the shaft in the Registry material this diagnosis has actually been suggested on account of this situation of the tumor. The features of this variety of osteogenic sarcoma will be pointed out more explicitly in the following chapter. The next seat in freqeuncy in the femur is the region about the great trochanter. Osteogenic sarcomata here are marked by the prevalence of cartilage. Degenerative changes frequently lead to cyst formation in these tumors. Occasionally the tumor appears to be attached to the trochanter by a well defined pedicle. The neck of the femur and the region close to the head are the seats of least frequency.

The second most frequently involved bone, the tibia, averages about 20 per cent of all cases. About 90 per cent of all cases situated in the tibia involve the region about the upper end of the bone. It is interesting to note that here the tumor is seen mostly on the internal aspect of the bone and very rarely on the lateral aspect. The remaining cases of osteogenic sarcoma are situated all along the bone except at the lower end.

The humerus carries about 9 per cent of all cases of osteogenic sarcoma, the majority being found in the upper third of the bone, very frequently about the insertion of the deltoid, while an osteogenic sarcoma below the deltoid tubercle is a curiosity. In the pelvis with its 5 per cent of all cases of osteogenic sarcoma the tumors are most frequently situated in the ilium, usually about the crest; sometimes they are found in the os ischium and rarely in the pubis. It is of

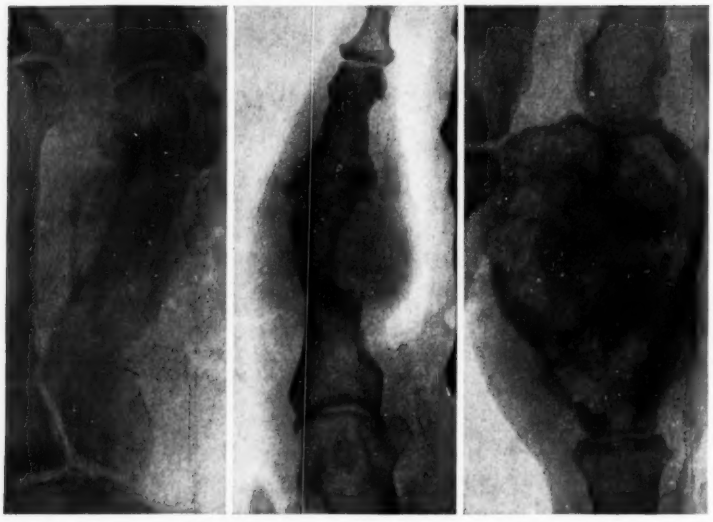


Plate 8. Roentgenograms showing (1, left) osteogenic sarcoma in a young woman; (2, center) solitary gout nodule which simulates an extraperiosteal sarcoma with pressure absorption of bone; and (3, right) enchondroma.

interest that the tuber ischii which is under frequent physiological stress is an uncommon seat of osteogenic sarcoma. The fibula is usually involved at its upper end; localization of an osteogenic sarcoma in the lower end of the fibula is rare. Of the bones of the shoulder girdle, the scapula is the seat of predilection, especially about the glenoid fossa. The ulna is usually affected at its proximal end, no case of osteogenic sarcoma in the distal end having been registered. Only the large bones of the feet are occasionally affected by osteogenic sarcoma; the phalanges of the fingers and toes are free from true osteogenic sarcoma (Plate 8). In fact no case of metastases from an osteogenic sarcoma of the phalanges is known. The skull is affected by osteogenic sarcoma mostly in children. An involvement of the lower jaw is more frequent than that of the upper. The vertebræ are very rarely the seat of an osteogenic sarcoma. An osteogenic sarcoma of the patella has never been registered.

The fact that a great majority of osteogenic sarcomata are found in the bones of the lower extremity led to a hypothesis that physiological stress and strain are in some way a predisposing factor in the etiology of osteogenic sarcoma. While it is true that the lower extremity is under incomparably higher stress and strain than the upper extremity, it cannot be denied that the spine far exceeds the lower extremity in this respect, yet osteogenic sarcoma of the spine is not common. On the other hand the localization of most osteogenic sarcomata about the knee, which is always exposed to trauma, suggests that trauma is a definite etiological

factor in osteogenic sarcoma. It has been mentioned above that the fact that the majority of osteogenic sarcomata occur in the young suggests that energetic skeletal growth plays a certain rôle in the etiology of osteogenic sarcoma. This suggestion is well in accord with the fact that the lower epiphyseal end of the femur and the upper epiphyseal end of the tibia are the last to ossify in the human being, remaining in the growing age until the first years of the third decade.

Osteogenic sarcoma is a solitary disease. In the literature where, under the heading of "bone sarcoma," are embraced together with osteogenic sarcoma also Ewing's sarcoma and myeloma, multiple bone sarcoma is frequently mentioned. It is of course not uncommon to find a multiple Ewing's sarcoma. In myeloma multiplicity is the rule. That myeloma has frequently been described as multiple "bone sarcoma" may be suspected from the fact that most reported multiple bone sarcomata were medullary in location. It would not be surprising if under certain conditions favorable for osteogenic sarcoma a patient should develop simultaneously more than one lesion; yet multiple cases are not common. It is impossible to decide whether a rare multiple osteogenic sarcoma is such from the start or whether one tumor is the primary growth and the others are of metastatic origin.

Sometimes an osteogenic sarcoma is superimposed on multiple chondral exostoses, in which case multiple osteogenic sarcomata may be encountered. Multiple lesions are also known to occur in patients with Paget's disease (osteitis deformans). Such cases often pass as metastatic from a single primary osteogenic sarcoma. Codman pointed out the fact that because most cases of osteogenic sarcoma occur under the age of 50 and most instances of Paget's disease are recognized over the age of 50 the presence of an osteogenic sarcoma in later life is almost presumptive of Paget's disease. The Registry material shows that in about 5 per cent of all cases of osteogenic sarcoma the tumor arises in Paget's disease. Codman believes that about 14 per cent of all cases of Paget's disease succumb to osteogenic sarcoma. It has been suggested that osteogenic sarcomata occurring in Paget's disease be separated as a definite entity. There is, however, no clinical evidence to support such a separation. As in most cases of osteogenic sarcoma, the etiological factors of osteogenic sarcoma in Paget's disease probably may be explained by local loss of growth restraint (repair restraint). Such a local loss of growth restraint when repair is called for has serious consequences in Paget's disease with its apparently constitutional weakness of general growth restraint (Plate 9).

In the clinical history of a patient with a primary malignant bone tumor there are two features which attract the attention of the diagnostician. One of these elements is pain, which is the first symptom in a patient with an osteogenic sarcoma. It precedes the appearance of a tumefaction by an interval lasting a

Plate 9. Courtesy of Dr. Holmes, Massachusetts General Hospital. Osteogenic sarcoma in a man of 40, with Paget's disease. The patient sustained a fracture of the femoral neck. While immobilized in a hip splint, he developed an osteogenic sarcoma. Roentgenograms taken soon after the fracture and 3 and 5 months later.

few days, weeks, or months. This symptom is of such importance that severe persistent pain in a long bone of a young adult should cause a suspicion of sarcoma. Pain is due to the high sensitiveness of the periosteum which invariably becomes affected to a greater or lesser degree in malignant bone tumors. Sometimes, however, pain is not proportionate to the seriousness of the condition; all the patient experiences first is a tired feeling, some uncertainty of the muscles about the adjoining joint and hence limping. When the process encroaches upon the periosteum, pain appears. Pain is of a very severe, boring, excruciating or rheumatoid and gnawing character. The suffering is especially agonizing and unbearable during the night, waking the patient from sleep. In fact the sleepless nights are the main cause of the run-down general condition so frequently seen in patients with osteogenic sarcoma. In the early stages pain may be intermittent in character. Pain of a rather dull character comes on immediately after trauma, lasts one to two weeks, disappears and all that is left is perhaps a slight limp. Some time may pass and the pain reappears, but of a deep seated excruciating character. Occasionally a new trauma precedes the reappearance of pain. Intermittent pain, however, is more typical of a Ewing's sarcoma than of osteogenic sarcoma.

The best explanation of the cause of pain is pressure of the tumor mass from within the bone upon the periosteum. That tension of the periosteum, and not pressure upon nerves as suggested by others, seems to be the cause may be concluded from the fact that in far advanced osteogenic sarcoma after the periosteum is perforated by the growing tumor mass, pain may disappear; the patient is up and around until a pathological fracture or metastases oblige him to become bed ridden. Pain is also relieved by drawing up the leg so as to relax the muscles overlying the tense periosteum. The spectacular and almost immediate disappearance of pain after radiation could hardly be explained by relief of pressure upon nerves, but it is well in accord with the radical influence of radiation upon the rapidly growing tumor. There are other conditions of bone in which pain is of similar severity, e.g., acute osteomyelitis with an accumulation of pus between the cortex and the periosteum. The pressure of the pus under high tension upon the periosteum causes the pain, and drainage here immediately relieves it. Similar pain is observed in syphilitic periostitis and in sclerosing non-suppurative osteomyelitis—conditions which greatly affect the periosteum. The appearance of pain is not in any way to be identified with the onset of the tumor. The not infrequent short duration of life after the onset of pain is the best proof that the tumor was present long before, and only when the periosteum became distended to a certain point did the pain call the patient's attention to the condition.

Another important element in the clinical history is trauma. The question of the importance of trauma as a diagnostic point in "bone sarcoma" has been

debated for years. As our knowledge stands today, one may say that trauma is an unreliable element in the history of a patient with a primary malignant bone tumor, and this is as true of osteogenic sarcoma, as of Ewing's sarcoma. The fact that statistical data vary greatly in the estimation of trauma indicates that there must be important sources of error in such statistics. The main error is evidently the question about which an immense confusion exists: "What is to be considered a trauma?" Is not a sudden tension of a muscle upon the bone to which it is inserted also to be considered a trauma? In accordance with the answer to this question the frequency of trauma in the clinical history will obviously change. Another error is due to the fact that the history of trauma is purely subjective and is apt to lack in trustworthiness; it is an old inclination of a patient to connect up his suffering with some external fact as a cause. We all frequently suffer traumata which usually pass unnoticed, but in the exceptional case when a tumor develops, we recall the trauma history. In some cases a trauma is mentioned by the patient for purely mercenary reasons. There also can be no doubt that in many cases the quasi-responsible trauma was sustained after the actual onset of the tumor. This fact is not sufficiently realized even by the diagnostician; meanwhile the occurrence of pulmonary metastases and death after a very short clinical course, 2 to 3 months after the discovery of the tumor by the patient, strongly support the possibility that the trauma in the patient's history took place after the actual onset of the tumor.

While there can be no doubt that the old motto, "When there is no trauma there is no tumor" is obsolete and not in accord with actual facts, there is, however, strong evidence to support the view that in general trauma may lead to osteogenic sarcoma under certain predisposing conditions. It is probable that trauma is the exciting cause of all osteogenic sarcomata but it seems that the particular trauma associated with the onset by the patient is seldom a causal trauma. The strongest argument against the importance of trauma in primary malignant bone tumors is the fact that osteogenic sarcomata are rare after fractures. However, sarcoma in callus after fractures does occur, to be sure not as frequently as one might expect if this kind of trauma were important in the etiology of osteogenic sarcoma (Fig. 41). As a matter of fact, the character of trauma preceding osteogenic sarcoma is usually not a severe blow producing a fracture, but a more or less slight trauma of the contusion type, frequently forgotten by the patient until reminded of it by the appearance of pain. In this all sarcomata differ from carcinomata where not a single but a repeated, more chronic trauma is important. Slight repeated traumatizing, however, is not infrequent in the histories of cases of osteogenic sarcoma. The trauma here is of a chronic irritative type, one which can hardly be qualified as a trauma in the usual sense of this word, for example an osteogenic sarcoma which arises in a bone scar of a cured osteomyelitis. Typical in this country are osteogenic

Fig. 41. Case 156. Osteogenic sarcoma in a boy 14 years old. The tumor arose at the point of a well united fracture which preceded the clinical onset of the tumor by 7 months.

sarcomata appearing after a sport trauma—football or baseball. In such cases the tumor is occasionally accompanied by myositis ossificans.

The question of how a trauma may lead to an osteogenic sarcoma furnishes ample material for speculation, most alluring being the theory of loss of repair restraint in the bone after the trauma. Important from a practical standpoint is the fact that the history of trauma is very frequently obtained from a patient with an osteogenic sarcoma and hence trauma plays a definite rôle as a diagnostic point in this disease. A history of trauma is more frequent in patients between the ages of 10 and 30, perhaps because they are more active and less careful than older people.

Of obvious importance is the time elapsing between the sustained trauma and the appearance of the tumor. In a large series of cases one finds the most discrepant intervals of time ranging between a few days and a year or more. The very short intervals of time are evidently of no diagnostic value; also the longer the intervals the less reliable is the history of the trauma. The most frequent interval is about one month between the time of the trauma and the appearance of pain or tumefaction. This interval is actually found in approximately one-third of all cases of osteogenic sarcoma.

Unlike carcinoma the general condition in malignant tumors of bone is generally good until the later stages of the disease. Of course night pains keep the patient in misery and may cause a rapid running down of his general condition, but as soon as this suffering is relieved spontaneously, by radiation, or amputation, the general condition of the patient is again satisfactory. Occasionally one observes a case of osteogenic sarcoma in which the temperature is high. The febrile stage usually lasts but a few days, disappears, and may recur at a later date. Such a febrile course, however, is more common in Ewing's sarcoma than in osteogenic sarcoma. When the patient enters the last stage—the generalization of the disease—a febrile stage is frequent, especially in the presence of pulmonary metastases with an accompanying consolidation of the entire lung. Along with the high temperature one sometimes finds hyperleucocytosis with a predominance of lymphocytes. Myelocytes are not a constant finding; when present they comprise about 3 to 5 per cent of the leucocytes. The clinical reaction of the patient to the disease in the terminal stage is also unlike carcinoma. Instead of cachexia, one encounters here a grave anæmia. The chalk pale patient has a characteristic haggard appearance, which when once seen is never forgotten. Occasionally the persistent lowering of the hæmoglobin, in spite of a good general condition of the patient, is a sign of a generalization of the disease. When the tumor is infected after an exploration, the general condition of the patient rapidly changes for the worse and may be followed by an appearance reminding one of cachexia.

The reaction of the skin overlying the affected region is also unlike that which is usually observed in carcinoma. While in carcinoma the skin overlying the

tumor early becomes involved, in osteogenic sarcoma the skin is persistently stretched by the tumor, but not invaded by it. It preserves its mobility and natural color for a long time. However, frequently the temperature of the skin overlying the involved area is distinctly higher than that of the neighboring areas. Early, dilated veins become noticeable. These dilated blood channels in the pale white skin give a striking danger signal to the observer. The skin usually remains intact, and if no exploration is done, an ulceration of the skin is rare. Occasionally, however, the skin becomes œdematous; it is tense and glossy, the superficial veins are very large. When the tumor is far advanced and the thinned out skin looks inflamed due to a dilatation of the superficial veins it acquires a purplish tint which may be followed by extensive excoriation. Inflammation may even go on to ulceration although this is very uncommon. These changes in the skin are of little diagnostic importance because they are observed late in the course of the disease.

The shape, outlines, and the consistency of the tumor are well perceived through palpation, and it is important to repeat such examinations frequently. By palpation one may often outline the anatomic borders of the tumor with a surprising exactness. Repeated palpation before and after radiation may bring out even the slightest changes in the consistency, size, and shape of the tumor, frequently most significant in establishing the diagnosis. In tumors with a very thin periosteal investing capsule and cystic degeneration one may encounter crackling; it is, however, a very uncommon finding. In very vascular tumors a pulsation and bruit can be felt. In the following chapter this feature will be dealt with in greater detail. Palpation may sometimes discover to the patient tenderness of which he was unaware before, since tenderness may be present in the absence of pain. It goes without saying that only when the utmost caution is exercised in palpation is the latter permissible.

The size of an osteogenic sarcoma is variable. In general in these days large malignant bone tumors are less frequent than twenty-five years ago—the tumor is usually diagnosed much earlier. Much depends on the seat of the tumor. When in close proximity to important structures an increase in size of the tumor may affect them and in this way draw the patient's attention to the disease. Usually only the primarily benign but potentially malignant skeletal chondromata of long duration reach a large size, before they become actual osteogenic sarcomata. The rapid and extensive regressive changes in malignant bone tumors may considerably slow down the increase in the size of the tumor. It is unsafe to attempt to state the time of onset of the tumor from its size. The rapidity of growth and the increase in size depends greatly on the consistency of the tumor tissue; the firmer osteoblastic tumors are of more moderate dimensions than the soft encephaloid variety. As a rule after the tumor breaks through the bone and the investing periosteal capsule, its rate of growth markedly increases. During

Fig. 42. Case 469. Osteogenic sarcoma in a boy 15 years old. Showing an extension of the tumor into the knee joint.

the course of an osteogenic sarcoma traumatism of any kind may lead to an acceleration of growth. By traumatism is meant here local direct as well as indirect general traumatism, for example hard physical labor, exercises of any kind, an exploratory incision or puncture of the tumor. After an exploratory incision the acceleration of growth is usually very acute. The fact that hard physical labor may have a sudden accelerating effect on the tumor may be important in the courts. The rate of tumor growth may be and probably always is accelerated by a pathological fracture through the involved area of bone.

In general, pathological fractures are not typical of osteogenic sarcomata. Usually tumefaction and pain are keeping the patient off his feet. They are more apt to occur in osteogenic sarcomata growing expansively in all directions in the involved bone, in the so-called central variety. The fracture follows a trifling trauma or force. It may also result entirely spontaneously and sometimes even without the patient's knowledge of it. Pathological fractures are usually transverse, not "green stick" but rather "rotten wood" fractures, although oblique pathological fractures do occur. Like pathological fractures in carcinomatous involvement healing of fractures here is not uncommon. Instead of callus it may unite by means of ossifying tumor tissue with a subsequent refracture when the new formed bone is destroyed by more cellular tumor tissue.

The reaction of the joint close to the involved bone end in malignant bone tumors is peculiar. It is interesting to note that a patient complains less of

Fig. 43. Case 316. Skeletal chondroma in a man 58 years old. Onset in 1913. Local excisions of the tumor and recurrences in 1915, 1920, and 1923. The histology of the last recurrence showed distinct malignant features. The present roentgenogram was taken before the last operation.

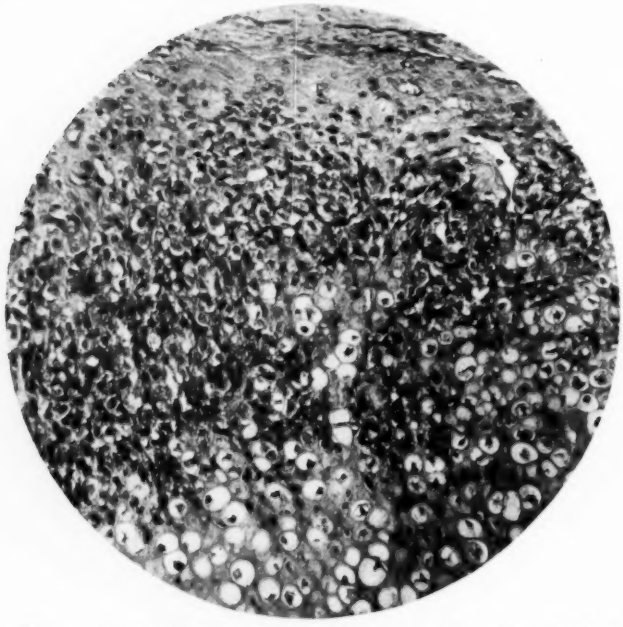


Fig. 44. Case 206. Same case as in Figures 45, 46, and 47. Skeletal chondroma. Showing a characteristic conglomeration of various typed cells beneath the fibrous capsule of the tumor.

articular pain in osteogenic sarcoma than in osteomyelitis. There may be initial soreness and perhaps an effusion into the joint cavity following trauma, but after the exudate absorbs, no articular discomfort is felt by the patient. Movements in the joint are free. In the far advanced stages of an osteogenic sarcoma there may follow a sarcomatous involvement of the neighboring joint. While involvements of the joint by extension from the tumor do not occur very frequently, they are, however, in my experience not uncommon. Because the articular cartilage is very resistant to sarcomatous involvement a penetration of the tumor into the joint does not take place through the articular cartilage (Fig. 42). It usually takes place following a pathological fracture through the involved end of the bone. Such joint involvement is more frequent in the adult than in the young, because of the completed fusion of the epiphysis; in the former the tumor frequently spreads directly in the epiphysis. When the joint is involved, it sometimes becomes distended with fluid and shows signs of fluctuation; this is, however, the exception and not the rule. Usually a fusiform enlargement of the joint slightly resembling a tuberculous arthritis is seen. Cases are even known of a diagnosis of tuberculosis on account of this similarity. On opening the joint the synovial membrane is found converted into a grayish red fungous tumor mass

Fig. 45. Case 296. Compare with Figures 44, 46, and 47. Showing the preponderating structure of the tumor—atypical cartilage.

which is in direct communication with the extra-articular tumor. Sometimes the synovia is converted into a large nodular encephaloid mass. The knee is the joint most frequently involved; but other large joints may be affected in a similar way. There is some evidence that an osteogenic sarcoma after perforating into the joint may involve the adjoining normal bone from within the joint cavity. This is, however, very unusual.

One of the most constant manifestations of the clinical course of primary malignant bone tumors is generalization of the tumor, through metastatic dislodgment. In the literature one frequently finds most definite statements as to the frequency of metastases in malignant bone tumors. Similar statistical data are of no value unless they are based on cases histologically proved to be osteogenic sarcoma with the presence of metastases well established. In primary malignant bone tumors all similar statistical data are of relative importance because of the exceedingly grave prognosis of the disease; in only exceptional cases does the patient live more than five years, while in the majority of cases death is a result of generalization.

The idea that the blood stream is the only path of spreading of metastases in sarcoma does not hold true in malignant tumors of bone. The lymphatic system

Fig. 46. Case 296. Compare with Figures 44, 45, 47. Focal hyalinization with ossification of the tumor.

occasionally plays a definite rôle in the transportation of tumor tissue in the organism. The importance of the blood channels in the generalization of the disease is, however, predominant. A perforation of the tumor mass into a blood channel is not uncommon, because of the intimate relation of tumor elements to the blood vessels as pointed out above. As a result of venous transportation of the tumor cells, pulmonary metastases are most frequent. From the lungs a dissemination may follow through the skeleton and parenchymatous organs. The perforation of a pulmonary metastatic mass into a bronchus with expectoration by the patient of fragments of seminecrotic tumor tissue has come under my personal observation. The incipient clinical signs of a pulmonary metastatic involvement may be the same as those in diffuse bronchitis. Sometimes a patch of pneumonia is diagnosed, the patient showing all the symptoms and signs of it—cough, dullness, fever, leucocytosis. In this connection it is important to remember that in cases in which, on physical examination, no involvement of the lung is found, a radiological examination may reveal early nodular metastases. Sometimes one is confronted with the necessity of differentiating in the roentgenogram between healed tuberculosis and tumor metastases. The best point of differentiation is the fact that in healed tuberculosis the nodules throw a deep, more or

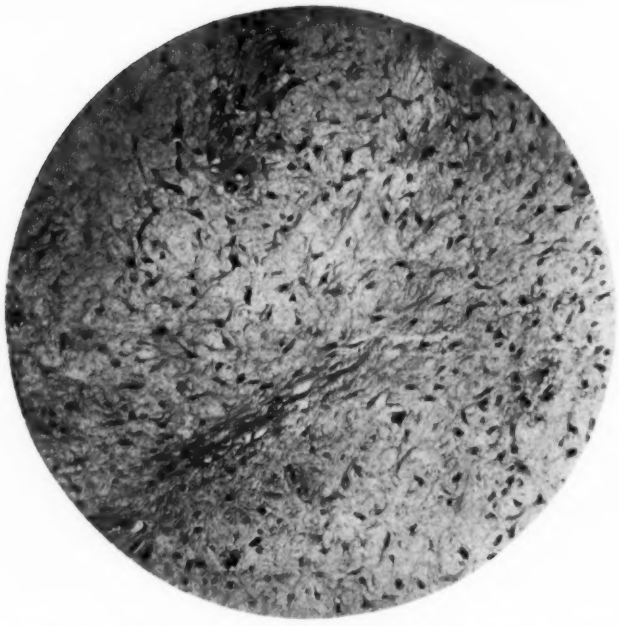


Fig. 47. Case 296. Compare with Figures 44, 45, and 46. Showing an area of myxomatous degeneration of the tumor.

less rounded shadow the size of a large pea; this is due to the calcification taking place in healed tubercles. In early sarcomatous metastases no bone production is present usually and the shadow in the roentgenogram is faintly outlined. Negative physical and radiological findings do not rule out an early pulmonary involvement. Typical sarcomatous metastases are globular in shape, few in number, and large in size.

In the absence of pulmonary metastases, metastatic tumors have been found in other organs, especially in the bones. Some of these may be explained by retrograde transportation of the dislodged tumor elements, through veins, to their new location. In some the absence of pulmonary metastases is probably more apparent than real; it is also known that radiological evidence of pulmonary metastases may entirely disappear temporarily after radiation therapy.

Spreading of tumor metastases through lymphatics is infrequent. It is obvious that a metastatic involvement of regional lymph nodes in malignant bone tumors means more as an indication of generalization than in carcinoma. An occasional simple lymphadenitis in malignant bone tumors should be clearly distinguished from a metastatic involvement of the nodes. Such a lymphadenitis is usually found following an infection after ulceration of the tumor or after an exploratory

incision. However, an inflammatory reaction in the regional lymph nodes is also encountered when there is no ulceration present.

Naturally, a question arises as to the interval of time between the onset of osteogenic sarcoma and the appearance of metastases. No definite answers as to this question can be made; in certain cases pulmonary metastases and death have been known to take place two months after the clinical onset, in others metastases have not been discovered until years after the onset. Usually metastases develop during the first two years after the onset. Cases are known in which pulmonary metastases led to the discovery of the primary tumor. In this respect osteogenic sarcoma is like carcinoma—not infrequently extensive skeletal carcinosis may be the first indication of the presence elsewhere of a primary tumor.

Skeletal chondroma is related clinically to osteogenic sarcoma. This is a primarily benign tumor which is notoriously persistent, grows to a large size, tends to recur after incomplete surgical procedures and finally to metastasize. The most frequently given history is that for some cause a tumor developed. It reached a considerable size; it remained benign for years until some kind of trauma, accident or a surgical operation, led to a sudden increase in vitality, to a distinctly malignant change, and to metastases and death. Putting it in terms of the repair theory the trauma calls for a new attempt at repair in the tumor; but because growth restraint is low or entirely absent, as is suggested by the primary development of the tumor, a more malignant tumor develops. The long space of time before a sudden turn for the worse after the trauma is the prevailing feature of this type of tumor. At operation the tumor appears perhaps not to involve the cortex of the bone on top of which it is situated, a local excision is done, and a rapid recurrence follows. Because of recurrence repeated local operations are performed. These surgical operations are followed by an increase in the blood supply of the tumor and by a change to malignancy. Their metastases and final course are typical of osteogenic sarcoma. These tumors are usually located in the diaphysis near the epiphyseal end of the bone. Sometimes they are distinctly pedunculated, in which case they are of far better course and prognosis. Frequently, however, the pedunculation is more apparent than real. They may lie entirely beneath the periosteum, projecting externally and pushing outward the periosteum; they may simultaneously grow in the medullary cavity, distend the latter and become surrounded by a thin bony shell. When they extend far, they may prove malignant from pure mechanical factors. The most frequent location of these tumors is the lower end of the femur, about the popliteal space (Fig. 43). Here they may reach an enormous size without great discomfort to the patient. They are frequent about the hip joint, especially about the great trochanter. The insertion of the broad pedicle to the trochanter is noted. In this location the tumors often pass for fascia sarcoma. Similar tumors are known to occur also in the upper end of the humerus and in the neck

of the scapula, about the glenoid fossa. Occasional instances of this tumor occur in various other locations. The histological structure of skeletal chondroma is manifold; it frequently resembles an osteogenic sarcoma with a preponderance of a cartilaginous matrix (Figs. 44 to 47).

Diagnosis

There are few chapters in medicine where exact diagnosis is hampered by so many difficulties as in malignant bone tumors. The confusion in the nomenclature and classification together with the fact that commonly these tumors are seen only at one or another stage of development, and the peculiarly complicated reactive processes of bone which contribute to the wide variations in their histological structure render the primary malignant bone tumors a complex diagnostic problem. Here it is that a collective study of many individual cases may greatly clarify diagnostic points. A very valuable contribution on the diagnosis of osteogenic sarcoma is written by Codman.[1] The diagnosis of malignant tumors of bone rests upon a careful consideration of the findings accumulated from all three angles of study: the clinical, roentgenological, and pathological.

Occasionally the history and clinical picture of the condition will suffice to establish the diagnosis, without the necessity of roentgenological or microscopical study; not infrequently a roentgenogram is more decisive in the diagnosis than a number of microscopical sections, but it is not at all uncommon for a most careful scrutiny and perusal of all available clinical and laboratory methods to prove insufficient for establishing a diagnosis. In general it is fundamentally wrong to emphasize the importance over the others of any one of the three angles of study, clinical, roentgenological, or pathological.

The importance of the history and the clinical course of a tumor of bone from the diagnostic standpoint has already been pointed out. These data are especially valuable in the early stage of disease when no tumefaction can be demonstrated. It is in this early stage that the patient's complaints are usually diagnosed as articular rheumatism. Articular rheumatism is the *primum refugium* of the unscientific physician not only in malignant skeletal tumors but in various other pathological conditions of the skeleton. It is indeed surprising how frequently this diagnosis is made by the physician in the presence of symptoms which, if evaluated intelligently, would lead one away from this diagnosis. Freedom of movement of the joint is an important differentiating feature between articular rheumatism and osteomyelitis on one side and osteogenic sarcoma on the other. In the latter, complete or relative freedom of motion in the adjoining joint is the rule except in occasional, far advanced cases when a secondary sarcomatous involvement of the joint proper takes place. Repeated careful palpation will not infrequently lead to an early discovery of a tumefaction.

[1] Codman, E. A. Registry of bone sarcoma. Surg., Gynec. & Obst., 1926, xlii, 381.

A clinical finding which is frequently misinterpreted and therefore misleading in the diagnosis is pulsation of the tumor. Allusion is made here to pulsation resident within the tumor itself and not to pulsation transferred to it from contiguous arteries. The occasional observation of pulsation and bruit in bone tumors has led to the diagnosis of these tumors as aneurysm of bone. One of the causes of pulsation in the tumor is richness in blood supply. In cellular, rapidly growing tumors extensive regressive changes may be followed by a formation of blood cysts and spaces which may cause pulsation. However, in skeletal tumors these factors cannot explain pulsation satisfactorily. The difference in the pulsation of a soft tissue tumor and a skeletal tumor may be brought out by a compression of the afferent main artery when the compression is followed by the disappearance of pulsation in a soft tissue tumor but not the entire disappearance in a pulsating skeletal tumor. This is probably due to the fact that the bone-marrow is pulsating normally. Apparently the influx and reflux of blood in the wide-meshed and thin-walled abundant capillaries transmits the pulsation to the delicate and loose cellular tissue of the bone-marrow. Whatever the exact nature of this tumor pulsation may be, it is fully attested that no aneurysmatic skeletal tumors exist.

To read and interpret correctly a roentgenogram of a bone tumor is an art acquired only with wide experience, combined with a thorough knowledge of gross pathology. For this reason individual statistics showing the high or low percentage of cases diagnosed correctly from the roentgenogram are not of much importance. The tendency in vogue a decade ago to overestimate the importance of a roentgenogram in the diagnosis of a skeletal tumor has been followed lately by a swing toward underestimating its importance. This swing has taken place because of the frequent errors in the diagnosis if one depends on the roentgenogram alone. The numerous difficulties which render a roentgenological study of an osteogenic sarcoma a complex problem are evident. The roentgenological features of an osteogenic sarcoma greatly depend upon the stage of the clinical course and upon the structural peculiarities in the tumor. The extensiveness of the tumor whether more medullary or cortical, the histological structure of the tumor, the destructive and proliferative bone reaction, the regressive changes with occasional subsequent formation of blood spaces and sinuses and cysts—these are just a few of the factors strongly influencing and complicating the roentgenological features of osteogenic sarcoma.

The great difficulties connected with the establishment of a correct diagnosis of osteogenic sarcoma from the roentgenogram, however, do not reduce its proper importance as a diagnostic aid. With our growing knowledge of this subject it is easy to see that in the future we shall have to make more extensive use of the roentgenological features of bone tumors for diagnostic purposes. From a study of the extensive material of the Registry one arrives at the conclusion that roentgenology is not sufficiently appreciated by the average physician in dealing with

bone tumors and too few roentgenograms are being taken. Not only among general practitioners and occasional surgeons but also in special surgical institutions the fact is not sufficiently realized that a roentgenogram is to be looked at as a method, harmless for the patient and most important for the physician, of frequent re-examination of a patient with a skeletal malignant tumor. In the presence of a suspected skeletal malignancy most of the bones of the skeleton should be examined roentgenologically. This is the only way to reduce *ad minimum* the number of cases in which a multiple tumor is to be mistaken for a solitary one. From the numerous unsatisfactory roentgenograms one sees how frequently most important technical points of roentgenology are not appreciated and are neglected. Probably the best films are secured with no screens and with long exposure. Because distortion is increased toward the margin of a film no details can be seen at the marginal zone of a large film which would warrant a diagnosis of importance. Such roentgenograms, to present details, must be taken with the proper tube and film—fine focused tube, small cone, small film. The Bucky diaphragm requires especial care since the lead striations showing up on a film in faulty technique cloud the picture and frequently prevent the correct analysis of it. Films at the usual two planes intersecting at right angles are indispensable here. Since a certain amount of detail is constantly lost in a print it is obvious that when important conclusions are to be drawn from the roentgenogram all studies ought to be made from the negative.

Speaking in general terms one may mention the following features of an osteogenic sarcoma which are frequently sufficient to differentiate it from other skeletal lesions. One of these features is the common absence of a definitely limited outline of the sarcomatous tumor. Since osteogenic sarcoma frequently spreads and for some time remains beneath its periosteal investing capsule a spindle shape of the tumor is common. In rapidly growing tumors the fusiform swelling is ossified only at the ends where the periosteal reaction succeeded in producing a bone shell in the investing capsule. In such cases the tumor will be revealed in the roentgenogram by a wedge shaped osteophyte at each pole of the spindle, springing from the periosteum and slowly fading away in the unossified soft tumor. The wedge shaped osteophyte is frequently spoken of as lipping of the periosteum. However, no one of the three mentioned features is absolute proof of malignancy, non-sarcomatous skeletal lesions sometimes presenting one or another of these features. This makes the diagnostic value of these points of only relative importance. In the presence of strong clinical evidence of malignancy roentgenological findings negative for malignancy are of little value.

The roentgenological appearance of an osteogenic sarcoma depends greatly upon the character of the bone reaction of the tumor and its degree of differentiation. It is chiefly roentgenologically that osteogenic sarcomata may be divided into osteoblastic and osteolytic. Taking general features, two types of ossification

can be distinguished in osteogenic sarcoma. One is the structural dense bone which springs from or is attached to the involved old bone, appearing on the roentgenogram as spicules radiating from the bone or as thin layers of osseous tissue parallel to the bone. The other type of ossification is structureless. The roentgen-ray shadow is spotted due to the presence of opaque areas in the tumor. It is commonly believed by radiologists that islands of opacity in a large tumor indicate that it is benign, since these areas are thought to be due to calcification and not true ossification. This belief is erroneous; frequently irregular so-called low grade bone will cast such a spotted, speckled shadow.

The most widely known roentgen-ray appearance of an osteogenic sarcoma is the so-called fan-like, sun-ray structure. The histology of these spicules and the probable cause of this arrangement has been mentioned above. This sun-ray arrangement of the new formed bone has for long been thought absolutely pathognomonic of osteogenic sarcoma. A similar arrangement in other skeletal lesions —in chronic inflammatory processes—is known to occur. Only in 18 per cent of the cases of osteogenic sarcoma of the Registry material a sun-ray arrangement of the new formed bone is seen. On the other hand cases of osteogenic sarcoma have been observed in which the arrangement of the new formed bone was in longitudinal striations. Such longitudinal striations, rare in osteogenic sarcoma, are usually observed in cases with a wide involvement of the shaft of the bone, similar in situation to that usual in Ewing's sarcoma.

There has been expressed an opinion in the literature that the arrangement of new formed bone in an ossifying tumor is chiefly dependent on its amount, on the rate of formation, and not on the nature of the cells from which it springs. These authors maintain that if the rate of growth of the tumor is slow and ossification tendencies are great, the newly formed bone is usually deposited with a spongy arrangement and not in radiating spicules. These statements seem purely contentious and unavailing in the face of the evidence accumulated from an examination of the Registry material with this point in view. If all cases of osteogenic sarcoma of the Registry are divided in two groups, in one group all cases before the twentieth year of age and in the other all patients above twenty years old; the first group—when the growth of the skeleton is at its height—shows that bone production is predominant in 86 per cent of all cases, while in the second group—when the skeletal growth has been completed—production of bone prevails in only 62 per cent. But the arrangement of the new formed bone in radiating spicules is also much more frequently observed in the first than in the second group. In the first group it is observed in 28 per cent of all cases and in 33 per cent of the cases of this group with bone production, while in the second group it is present in 8 per cent of all cases and in 13 per cent of the cases of this group with bone production. These figures speak against the suppositions mentioned above that the frequency of the arrangement of the formed bone in spicules is in inverse

ratio to the amount of the new formed bone. It is evident that the age of the patient exerts a great influence upon the amount of new formed bone as well as on the arrangement of the bone.

In the osteolytic osteogenic sarcomata, the periosteal reaction together with the lipping of the periosteum may appear very late; therefore waiting for the typical lipping for the diagnosis is not recommended. In the usual osteolytic osteogenic sarcoma the roentgenogram shows, at first, expansion of the involved bone to a small degree. Then the bone shadow becomes spotted because of areas of bone destruction. In the print such a roentgenogram looks as if one erased the bone in spots (Fig. 48). Such cases resemble metastatic skeletal tumors with a predominance of destruction. It is in such cases that a pathological fracture is a more or less frequent complication. In rare instances of osteogenic sarcoma the destruction of the bone is more circumscribed and limited to a smaller area; this is usually observed in tumors located in or about the epiphysis (Plate 10).

A large expansion of the involved shaft is rather an exception and not the rule in osteogenic sarcoma. The old shaft is usually seen in osteogenic sarcoma passing not expanded through the fusiform tumor mass. The sclerosed shaft may even appear in the roentgenogram to be shrunken. That there are exceptions when the bone is first expanded and then destroyed has been mentioned above. Such a course is usually observed in cases with a wide

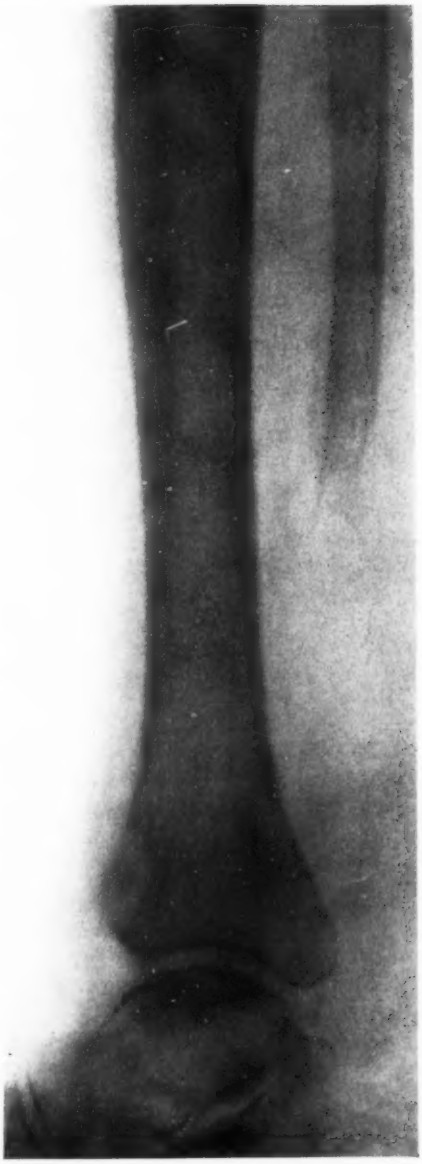


Fig. 48. Case 129. Osteogenic sarcoma in a woman 55 years old. Osteolytic variety. Death 1 year after onset.

Plate 10. Case 473. Osteogenic sarcoma in a boy 11 years old. Osteolytic variety which is uncommon in the young. The tumor was curetted because of an erroneous diagnosis of giant cell tumor. Death 10 months after the onset.

involvement of the shaft of the bone, slightly resembling Ewing's sarcoma roentgenologically. The shaft of a bone surrounded by an osteogenic sarcoma and appearing normal in the roentgenogram is not to be considered free of involvement; a tumor may show up well around a bone which casts a normal appearing shadow despite an extensive involvement of the haversian system and medullary cavity. For the same reason to attempt to define the extent of involvement by roentgenological evidence alone is hazardous in surgical therapeutic considerations.

Important for the diagnosis as some roentgenological features of osteogenic sarcoma may be, it would be misleading to consider them as absolutely pathognomonic. Setting up rules in the roentgenology of bone tumors will only contribute greatly to the discredit of roentgenography as a leading diagnostic method in skeletal oncology. Most of the roentgenological diagnostic points enumerated

Fig. 49. Case 222. A benign osteogenic tumor in a man 22 years old. Onset in 1910. Local excision in 1914. The patient was well in 1923. Note the sharp outline of the base of the tumor, the uniform density of the tumor and its jagged, velvet-like dome.

above may become worthless in an attempt to differentiate from osteogenic sarcoma a skeletal lesion with the same given roentgenological feature. For these reasons it is important to review here the skeletal lesions most frequently confused roentgenologically with osteogenic sarcoma, and to stress the chief

Plate 11. Case 216. See Figure 19. Osteogenic sarcoma in a woman 27 years old. Notice the speckled appearance of the tumor in the roentgenogram. The tumor cells are highly differentiated; bone with excessive cartilage formation make up the bulk of the tumor.

differentiating points. The differentiation from osteogenic sarcoma of other primary malignant skeletal tumors as well as giant cell tumors will be dealt with in the corresponding chapters.

As was mentioned, one of the most important roentgenological features of osteogenic sarcoma is that it is rarely definitely limited. However much depends on the stage in which the osteogenic sarcoma is seen; not infrequently after intensive radiation the tumor commences to cast a quite sharply limited shadow. In these instances the roentgenogram may not be inconsistent with the appearance of a benign osteogenic tumor. However the uniform density of the benign tumor, with the dome of the tumor jagged, velvety like, because of its cartilaginous covering, will frequently help to decide the diagnosis. In a benign osteogenic tumor there will be in most cases a sharp outline of the tumor toward the bone and the surrounding soft tissues (Fig. 49). A benign osteogenic tumor has cartilage on the external surface only, in imitation of the articular ends of long bones; cartilage dispersed throughout the tumor mass speaks for osteogenic sarcoma and against benign osteogenic tumor. Lipping of the periosteum is absent in a benign osteogenic tumor. It is also very unusual for a benign tumor to present the spindle form typical of osteogenic sarcoma. There is, however, a condition which, although rare, may puzzle the diagnostician because of the spindle shaped shadow of the roentgenogram even with presence of lipping of the periosteum. It is a subperiosteal hæmorrhage in hæmophilia. The periosteum is stripped away by the extravasation, the whole process forming a fusiform swelling. The pressure of the blood upon the bone may be so high as to cause an erosion of the cortex. Such cases have been reported in the literature. Similar confusion may be caused by Moeller-Barlow's disease with the only difference that there the hæmorrhages are usually limited to the diaphyses of the long bones.

That the sun-ray arrangement of the new formed bone was present in the Registry material in only about 18 per cent of cases was mentioned above; there was also indicated that such a radiation of the new formed bone lamellæ may be seen occasionally in chronic inflammatory conditions of the skeleton. Even less dependable for the diagnosis of osteogenic sarcoma is the longitudinal striation of the new formed bone, when the old cortex seems to be frayed longitudinally. It is not unusual to find such a structure in periostitis whether traumatic or inflammatory. In traumatic periostitis, however, the outline of the shaft remains distinctly limited and the cortex uneroded by the exostoses. It is uncommon for traumatic periostitis to surround the whole periphery of the bone as does osteogenic sarcoma. That, as a result of traumatic periostitis, large tumors may appear is known from the literature. In connection with this one has to consider also myositis ossificans, which is especially confusing when accompanying an osteogenic sarcoma as it is occasionally observed in osteogenic sarcoma after sport injuries.

Plate 12. Case 533. Multiple intra-osteal chondromata in a girl 8 years old. The entire skeleton was involved. The histology was inconclusive. Heavy radiation led to local improvement.

One can be more baffled in diagnosing a skeletal lesion by the possibility of a periosteal or cortical gumma than by periostitis. The similarity between syphilitic skeletal lesions especially gummata, and osteogenic sarcomata may be so great that despite all precautions many experienced diagnosticians have met with errors at some time or other. This is sufficient reason why one should refrain in doubtful cases from attempting a diagnosis before the result of a blood Wassermann reaction or even a provocative reaction is known. There are, however, some points which may help one in differentiating between syphilitic skeletal lesions and osteogenic sarcoma. A gumma is growing less rapidly than a sarcomatous tumor; the regressive changes in gumma take place much earlier than in osteogenic sarcoma. The extensive destruction of bone by gumma in the presence of a small sized tumor and the common absence of the periosteal spindle speak well for gumma and against osteogenic sarcoma.

When the new formed bone is present as foci throughout the tumor mass the roentgenogram is characterized by a spotted appearance. A picture similar to that is observed in skeletal chondroma. The calcified foci disseminated throughout the cartilaginous tumor cause a characteristic speckled mottled appearance with the individual spots sprinkled about (Plate 11). The differentiation in the roentgenogram between skeletal chondroma and osteogenic sarcoma is feasible. The sharply outlined pedunculated base of the tumors springing from a bone without any demonstrable pathological changes and the absence of the periosteal spindle will frequently suffice to establish the correct diagnosis. More difficulties may be encountered in intra-osteal and multiple chondromata. They are frequently seen in the upper portion of the femur, about the great trochanter. In such instances the question of differentiating between these tumors and an osteolytic osteogenic sarcoma may arise (Plate 12). At variance with osteolytic osteogenic sarcoma is the thinning of the cortex in central chondromata, and also the honeycombed structure with the thin, well defined bony septa traversing in the roentgenogram the defect in the osseous tissue of the bone. Not infrequently a question arises of differentiation between an osteolytic osteogenic sarcoma and skeletal carcinomatous metastases. This is hardly possible from the roentgenogram alone, but the presence of lipping and an unexpanded shaft speak for sarcoma.

More uncommon is the necessity of differentiating between osteogenic sarcoma and a bone cyst. Such a differentiation meets with fewer difficulties. This is especially true in more advanced cases. The clinical similarity between a bone cyst and osteogenic sarcoma may be great. The rheumatoid night pains, tenderness, although less marked than in osteogenic sarcoma, and pathological fracture all may be present with a bone cyst. Thus the clinical picture of a bone cyst as it usually appears in the young greatly resembles osteogenic sarcoma and the clinical examination alone will be insufficient for an accurate diagnosis. A

Fig. 50. Case 371. Osteogenic sarcoma in a boy 16 years old. Typical as to location and radiological appearance. The roentgenogram was taken 2 months after the onset at which time pulmonary metastases were demonstrated. Death 7 months after the onset.

roentgenogram will be almost indispensable although in the early stages a roentgenogram may be of no avail in the attempt to differentiate the lesion from an osteogenic sarcoma. The chief sign of a bone cyst is that it is always intra-osteal, i.e., central. Its presence usually leads to some expansion of the shaft; the cortex may become very thin but it is uncommon to have a perforation of the bone shell. Theoretically there is no reason why an actively enlarging bone cyst should be unable to perforate the cortex, but clinically such a perforation is a curiosity, probably because a pathological fracture interrupts the activity of the cyst when the latter is little short of a cortical perforation. When the cyst is located in the diaphysis it is usually ovoid in shape while the roentgenogram of a cyst in the ends of the bone may show a trabeculation similar to giant cell tumor.

Fig. 51. Personal observation; case not registered. Osteogenic sarcoma in a girl 8 years old. Death 9 months after the onset. The shaft of the bone is seen passing through the tumor which surrounds it. The periosteal spindle and the periosteal lipping are seen. The tumor stops abruptly at the epiphyseal junction.

In the roentgenogram, the condition most frequently confusing the diagnosis of a malignant bone tumor is chronic low grade osteomyelitis. Because it is most frequently diagnosed erroneously in the presence of Ewing's sarcoma, the points differentiating it from malignant skeletal tumors will be discussed in detail later. The differentiation from skeletal tuberculosis will rarely cause difficulties in the diagnosis. The fact that osteogenic sarcoma is generally met with in young adults in apparently the best of health is in great contrast to tuberculosis which is usually observed in persons with a general condition below par. Sarcoma and tuberculosis also differ in location; e. g. osteogenic sarcoma very rarely if ever begins in the epiphysis of the bone while tuberculosis nearly always involves the joint end of the bone and primary diaphyseal tuberculosis, although known, is exceptionally rare. While in sarcoma the overlying skin is reddened early because of dilatation of superficial veins, in tuberculosis the skin is usually paler than normal.

Roentgenograms of osteogenic sarcoma in the same location in patients of about the same age reveal certain common characteristic features which may be best appreciated from a study of typical instances. I have attempted to present here as illustrations roentgenograms of characteristic types of osteogenic sarcoma

Fig. 52. Case 269. Osteogenic sarcoma of the myxomatous variety in a man 68 years old. Showing slight expansion of bone and a trabeculation of the medullary cavity.

Fig. 53. Case 535. Osteogenic sarcoma in a man 28 years old. The speckling in the roentgenogram is typical of osteogenic sarcoma of the upper femur, in the trochanteric region, due to excess of cartilage and calcification foci in it. Death 11 months after onset.

(Figs. 50, 51, 52, 53; Plate 13). Especial mention should be made of the variety of osteogenic sarcoma which is situated in the diaphysis of the femur. As it was pointed out above, about 8 per cent of all osteogenic sarcomata of the femur have such a location.

Plate 13. Personal observation; not registered. Osteogenic sarcoma in a boy 18 years old. Roentgenogram (left) taken 3 months after onset. An exploratory operation was performed at that time and the pathologist reported "osteomyelitis." Right, Roentgenogram taken 7 months after the onset.

It is with great care that a diagnosis of osteogenic sarcoma should be made when a tumor involving the midshaft rather than the end of the femur is met in a young individual, since such a location is characteristic of Ewing's sarcoma. A differentiation of such an osteogenic sarcoma from Ewing's sarcoma can hardly be made from the roentgenogram, save in the far advanced stage; a microscopic study is indispensable here. A careful follow up of the clinical course of this variety of osteogenic sarcoma seems to indicate that the tumor passes through two phases. The first phase is the osteoblastic; the bone is slightly expanded but distinctly denser than normal and no distinct tumefaction can be made out as yet. Then the disease enters the second phase; the bone becomes considerably widened, and at one point or another a rapid destruction of the bone commences (Plate 14). The widening of the shaft may be accompanied by the appearance of longitudinal striations (Fig. 54). With the progress of bone destruction a large extra-osteal tumor appears. The bone destruction is so rapid that a pathological fracture is not uncommon in these cases; the frequency of spontaneous fractures probably being augmented by the situation of the tumor in the middle of a long, weight-bearing bone. Occasionally myositis ossificans may be confused with this variety of osteogenic sarcoma. Unlike osteogenic sarcoma, myositis ossificans usually develops during the first three or four weeks after the onset with trauma with a subsequent period of quiescense. The consistency of the tumor in myositis ossificans is bony hard in contrast to the firm but resilient feel of osteogenic sarcoma (Plate 15).

While an attempt to diagnose a skeletal lesion suspected of malignancy from the clinical and roentgenologic angle does not involve any procedures which are apt to influence the natural course of the tumor in any way, an examination from the pathological angle is possible only after direct encroaching upon the tumor mass. This fact alone would seem to narrow the clinical importance of the pathological angle of examination as a preliminary step toward diagnosing the skeletal condition. The uncertainty of a clinical examination and the diagnostic limitations of roentgenology, however, foster the importance of the pathological angle of examination in these tumors. The frequently encountered regressive changes, spontaneous or after radiation, inflammatory changes, traumatic or of infectious nature, and various peculiarities of the histology of osteogenic sarcoma make it desirable to diagnose a malignant skeletal tumor from the gross appearance, without dependence upon the microscopical picture. As it is easy to see from the gross anatomy of osteogenic sarcoma, the prerequisite of such a diagnosis is wide experience in this relatively rare disease. A pathological diagnosis of malignant skeletal tumors is not always dependable and the personal equation of the pathologist counts greatly in the diagnosis; sometimes even a diagnosis based on examination of numerous slides of a bone tumor may not be correct. Such examinations are notoriously unreliable when the material to be examined

Plate 14. Case 639. Osteogenic sarcoma in a girl of 12. Notice location in the midshaft of the femur. Roentgenograms taken one month after onset showing bone denser than normal; and 4 months after onset showing tumefaction and extensive destruction of bone.

Fig. 54. Case 638. Osteogenic sarcoma in the midshaft of the femur in a girl 14 years old. Showing the combination of features of osteogenic sarcoma—radiating spicules; and of Ewing's sarcoma—the widening of the shaft and parallel striations. Death 3 years after onset.

Plate 15. Case 263. Myositis ossificans in a man 34 years old. The onset in July, 1919, with a tumor of the fibula (roentgenogram 1). In November, 1919, the involved part of the fibula was resected, but in February, 1921, a recurrence was noticed (roentgenogram 2). In February, 1923, an amputation was performed (roentgenogram 3). Notice the striations of the ossified muscle bundles. This case was interpreted by some pathologists as an osteogenic sarcoma.

consists of tumor tissue removed in biopsies. I have seen cases of osteogenic sarcoma in the Registry material in which repeated biopsies, even five in the same case (616), were made to secure tissue for diagnosis while the correct diagnosis became obvious after all these explorations only from the rapid growth of the tumor infected during the exploratory operations. It is easy to understand why, when the differential diagnosis of bone tumors is uncertain by any single method, there exists a tendency to "explore" the tumor and to shift the task of diagnosis to the pathologist. Although a biopsy of a bone tumor is frequently advocated by surgeons, it is significant that pathologists most experienced in bone tumors raise their voices against probatory incisions in cases of suspected malignant bone tumor. It would seem that the attempt to neutralize the bad effects of a probatory incision by intensive cauterization of the operative wound is unavailing, since the dangers of an exploratory incision are not merely the possibilities of dislodgement of metastases but also the surgical insult combined with the irritation of the escharotic used which may increase the rate of growth of the tumor. Cases have been seen in which an infection brought in during such an exploratory incision led to a stimulation of the growth of the tumor. It is true, of course, that frequently an exploration will relieve the patient of pain because of decrease of the tension beneath the periosteum, following the evacuation of sarcomatous tissue; but soon the tumor will begin to grow rapidly. If an exploratory operation is decided upon, it should be remembered that in tumors previously irradiated it may be difficult to secure a sufficiently vital and representative piece of tumor to warrant a histological diagnosis. In removal of tissue for diagnosis all the removed tissue should be saved, because the recurrent tufts mixed with granulation tissue and infection are dangerous for a histological examination and may lead to an erroneous diagnosis and sacrifice of the patient's limb in the presence of a benign tumor.

As a substitute for the harmful exploratory incisions in doubtful cases of bone tumor a therapeutic radiation test has been suggested. Recent experience has furnished sufficient evidence to justify the belief that radium or roentgen-ray radiation may frequently replace a biopsy. It may be safely stated that no skeletal lesion responds so rapidly to radiation as do certain types of malignant tumors. The most agonizing constant pain frequently disappears after one or two exposures. The rate of growth slows down remarkably so that a speckled and hazy roentgen-ray shadow of a diffusely and rapidly growing osteogenic sarcoma soon acquires a more or less well limited outline; the shadow becomes denser, more compact (Plate 16). The most rapid response to radiation is noticed in Ewing's sarcoma and cellular osteogenic sarcoma. The response is less frequent and prompt in acellular and highly ossifying tumors, although the subjective relief is frequent also in this variety. It is fully ascertained that a preliminary radiation test will frequently help one to arrive at a diagnosis without an exploratory incision. For

Plate 16. Personal observation; not registered. Osteogenic sarcoma in a boy 5 years old. Death 9 months after the onset. Showing the response of the tumor to radiation. Between the two roentgenograms an interval of 3 weeks has passed, during which time the patient was given 3 half hour exposures to 200,000 volts of roentgen rays.

better evaluation of the results of a radiation test it is important to have the roentgenogram of the lesion before and after radiation of equal density. To secure the latter it should be remembered that the density of a roentgenogram is the result of the intensity of exposure which is directly proportionate to the current, to the square of voltage, and to the time of exposure and indirectly proportionate

to the square of the distance of the tube from the film. The density also depends upon whether screens are used or plain films.

Therapy

In bone sarcoma as in other malignant tumors the question of the therapy is still awaiting its answer. It is a strange fact that with our knowledge of minute details of the histopathology of bone tumors the progress along the practical therapeutic road is almost in the same stage that it was in some fifty years ago. As a rule malignant bone tumors are fatal and we know of no therapeutic method to prevent death from this disease. Occasionally one sees in the literature the term "cure" in connection with bone sarcoma. The word "cure" is not to be taken in the real sense of the word, usually a five years' cure is understood; this term is valuable only in comparative studies. Patients with osteogenic sarcoma who were free of metastases for years after amputation have later died of pulmonary metastases. It is an exaggeration to say that a tumor from which the patient has recovered is not a malignant bone tumor; but in such a statement there probably is more truth than error. The relative individual character of the term "cure" is one of the reasons why all statistical data of cure from bone sarcoma through one or another method of treatment are nearly worthless. Too many subjective, unstandardized factors are in play in such statistics to render them of value; apart from what is meant by "cure" much depends upon the stage of the disease when treated, upon the method and character of treatment and upon other changeable factors. Mistaken diagnoses are not infrequent in such reports. Cases of osteitis fibrosa, skeletal syphilis, and other bony lesions, erroneously interpreted as sarcoma will obviously raise the frequency of "cure." Of the same value are also the reports of spontaneous cure of bone sarcoma. It is true that authoritative observers have described regression in growth and development after partial surgical removal but no authentic cases of malignant bone tumor can be found among the reports of spontaneous cures.

To the end of the past and the beginning of the present century belongs the origin of the immuno-therapeutic attempts to cure or relieve patients with malignant tumors including bone sarcoma. The sponsors of these therapeutic measures set out from a viewpoint that malignant tumors are of a parasitic infectious nature. These attempts are also based upon observations of spontaneous disappearance of malignant tumors after an erysipelatous infection of the patient. The toxin and sera therapy of malignant tumors form a most romantic chapter in the history of these diseases. Being enthusiasts, the authors were easily impressed by doubtful results readily explainable on other grounds. And truly, what could be more enchanting than to make the organism immune to the infectious, fatal tumor? One after another the various, ingenious methods of immunization and detoxication were raised merely to fall discredited.

From all the various attempts at specific therapy we have today left only Coley's mixed toxins. The theoretical idea underlying Coley's toxins is active immunization of the patient. After long experiments with numerous preparations of various streptococci with and without the combination with bacillus prodigiosus, Coley arrived at the following way of preparing his toxins. A ten day old agar culture of bacillus prodigiosus is sterilized by heat and added to a sterile three weeks old streptococcus broth culture in the approximate proportion of 100 cubic centimeters of streptococcus culture, 30 cubic centimeters of suspension of the prodigiosus culture, and 20 cubic centimeters of glycerin. This preparation is introduced subcutaneously or intratumorally. It is Coley's belief that if, after four weeks of intensive treatment with the toxins, no marked improvement is registered, then the expectations from this therapy are poor. When the tumor responds to the treatment, Coley recommends continuing this therapy for a year or longer. The usual reaction to a foreign protein, fever, chills, dyspnœa, vomiting, and general malaise, are not infrequently observed. From a study of the abundant literature of this subject and of the material of the Registry one cannot agree with the enthusiastic reports of Coley. Many advanced and inoperable cases which have responded well to Coley's treatment have proven to be giant cell tumors for which it is not very unusual to see spontaneous improvement after a pathological fracture. However, whatever one may think of Coley's toxins one is amazed at the sincere honesty and tireless ambition with which Coley has worked on the development of this method of treatment.

Of late we frequently hear of the importance of Coley's toxins in combination with roentgen or radium radiation. The fact that this new wave of enthusiasm for the toxin takes place in days when radiation is brought into extensive practice is apt to make very dubious the importance of the toxins in themselves. There is no proof, however, to deny the validity of the argument that toxins increase the effect of radiation. The question of the way Coley's toxins could influence the tumor is too obscure to be discussed here. A general reaction of the organism to a foreign protein is probably the best explanation. During the long history of the therapy of bone sarcoma there was a time when chemical therapeutic methods were in vogue. It is safe to say that nothing has been achieved in bone tumors from chemotherapy; formalin in 10 per cent solution is occasionally used in inoperable ulcerated tumors as a deodorant.

Until recently operative therapy of malignant bone tumors has been the method of choice. This despite the fact that with the highly developed surgical technique and skill it is still impossible by operative treatment to influence the metastases of the tumor latent in other organs. It is hardly necessary to argue here the evident fact that radical surgery alone is unable to solve the therapeutic question of bone sarcoma. At first glance it is strange that, although the experience of radical surgery has been disappointing, it has until recently dominated all

therapeutic considerations in bone sarcoma. In their attitude toward the question of operative treatment of bone sarcoma two extreme types may be observed among surgeons. To one belong those who, at a slightest suspicion of bone sarcoma, amputate the extremity. Their argument is plain; it is better to sacrifice a limb than the whole organism. Frequently in these cases the surgeon never knows the true nature of the lesion; all goes well, and the number of "cures" from surgical treatment is large. To the other extreme belong surgeons who will doubt the diagnosis of malignancy in the absence of any of the characteristic symptoms of the disease, frequently despite a histological diagnosis. To these surgeons malignant bone tumor also spells amputation, a most radical operation to avoid which the diagnosis is doubted until, as a court of last resort, amputation is performed. Procrastination and delay here make the amputation entirely futile from the start.

From an analogy between bone sarcoma and carcinomatous tumors a question suggests itself: could not an early diagnosis combined with radical surgical treatment solve the problem of therapy in bone sarcoma as it occasionally does in some types of early diagnosed and well localized carcinomatous lesions? There is abundant evidence on hand to the effect that nothing is known that would help to establish a diagnosis of bone sarcoma in an incipient stage. Instances of osteogenic sarcoma are occasionally seen in which in spite of the fact that an amputation is made a few weeks after the subjective onset of the disease, death follows from pulmonary metastases. This would seem to indicate that a metastatic dislodgment of a malignant bone tumor is incomparably more rapid than in malignant tumors in soft organs or, what is more probable, that the subjective onset does not correspond to the true onset of the disease, which passes on unnoticed and gives rise to metastases before it attracts the attention of the patient.

In the consideration of the question of the indications for radical surgical treatment in a case of osteogenic sarcoma there are certain conditions which play a decisive rôle. The main condition is certainty of the diagnosis. In the large majority of cases the experienced diagnostician will arrive at a definite diagnosis from a careful analysis of the clinical and radiological data and of the result of the therapeutic radiation test. There will be, however, in exceptional cases times when the experienced observer will be unable to arrive at a definite diagnosis; in these cases an exploratory incision will be unavoidable. In such cases the surgeon must be prepared to act according to the diagnosis, and before operation he must have the consent of the patient to amputation. To explore simply for diagnosis and then to institute conservative treatment in case of malignancy is one of the most radical mistakes made. For the clinician well acquainted with the gross pathology of bone tumors, an exploration with an application of two constrictors is of real value; the distal constrictor is to prevent dislodgment of

Plate 17. Courtesy of Dr. Baker, Newark; not registered. Osteogenic sarcoma in a boy 16 years old. The roentgenogram was taken 2 weeks after the clinical onset of the disease. Very little is to be seen in the roentgenogram except for a slight jagging of the internal aspect of the femur (arrow). A roentgenogram of the chest made on the same day revealed far advanced pulmonary metastases.

metastases from the area of exploration while the proximal constrictor is for an immediate amputation should the tumor be found malignant.

The second condition in the consideration of indications for radical surgical treatment is the old rule in surgery of malignant tumors, "all or nothing." Do not operate if you think that complete removal and eradication of the primary tumor is impossible. This rule alone excludes surgery in osteogenic sarcoma of the spine, skull, and pelvis.

Another condition upon which an indication of surgical treatment is based is absence of clinical evidence of metastatic generalization of the tumor. A radiological examination of the lungs is required before instituting surgical treatment in osteogenic sarcoma (Plate 17); small metastatic foci which cannot as yet be perceived by percussion and auscultation will frequently be demonstrated in the radiogram as light, cloudy spotting in the normally dark lung shadow in the film. A preliminary radiological examination of the whole skeleton will occasionally save the surgeon from disappointment when multiple tumors or bone metastases are present. As exceptions to all these requirements for indication of radical surgical treatment are patients suffering unbearable pain which cannot be ameliorated by radiation. In such patients surgical treatment should be considered even in the presence of features which in an ordinary case will contraindicate such treatment.

After the indication for operative treatment has been established a question will arise of choosing between a conservative surgical procedure and a radical one. This question is almost as old as surgical therapy of malignant bone tumors itself. It was Mikulicz who first emphasized the advantages of tumor excision and bone resection over amputation and disarticulation. There is little if any difference between these two methods of surgical treatment, radical and conservative, as far as metastases are concerned, and if the resection or excision of the tumor is well done there is no reason why metastases should be more frequent than after an amputation. However, the main motive pointed out by Mikulicz, that a patient will sooner meet the necessity of a resection than a crippling amputation has lost ground at the present time with the high development of prosthetic surgery; it is indeed well known how very frequently an artificial limb is of incomparably more use and comfort to the patient than a leg with a stiff joint or with a constantly aching bone. Bloodgood has frequently mentioned that it is not unusual for his patients to become more efficient after an amputation; an artificial limb is frequently well borne by young patients even in dancing. It is true that in many cases the tumor can be removed just as completely by resection as by amputation; however, the hazards of the operation in connection with the dangers of overlooking involved tissue are great enough to strip the method of resection of all advantages over a more radical procedure, and unless the tumor involves a region for which no satisfactory artificial limb can be fitted, amputation is to be

preferred to any conservative surgical procedure. To resect the tumor and graft bone in a patient with an osteogenic sarcoma is an unwise procedure, not in accord with the palliative character of the operative measure.

If the choice between resection and amputation can be argued by a surgeon experienced in bone pathology, it is entirely out of place when the patient is in the hands of the surgeon operating only occasionally for bone tumor, for whom the method of choice is amputation or disarticulation if operative treatment has been decided upon. But even before the experienced observer decides to excise or amputate, it is advisable as a preliminary step in the operation to explore the main blood vessels, since if these are surrounded by tumor, amputation is the only choice. It is significant that the surgeons most experienced in bone tumors at the present almost wholly prefer amputation to resection or excision.

Excision usually comes up in borderline cases of bone tumors like skeletal chondroma. With this tumor any partial, conservative operative procedure is dangerous; indeed, no operation which leaves a trace of these quasi pedunculated tumors should be advised. It should be remembered that the apparent gross integrity of the cortex of the bone to which the tumor is attached is not dependable. In excising these tumors it is best to chisel away liberally the cortex upon which the base of the tumor rests.

Another conservative surgical procedure which dates back at least 50 years is ligation of the main artery supplying the region of the tumor involvement (Plate 18). In the literature one finds indications that sometimes such a ligation in a telangiectatic sarcoma leads to healing of the tumor for years. Recent attempts to influence a very vascular sarcoma by means of ligation of the afferent artery were unsuccessful, thus throwing a shadow of doubt upon the true sarcomatous nature of the tumors reported in the old literature.

Whatever the operative procedure decided upon, whether amputation or excision, it should be kept in mind that in muscles the spreading of sarcomatous tumors may easily be overlooked, and since the tumor, after perforation through the investing capsule, rapidly spreads along the intermuscular septa an extensive dissection of the muscles is most important. If operation is going to help temporarily, amputation of the involved bone may be sufficient, and a disarticulation of the proximal joint is unnecessary. Death takes place not from a recurrence because of a low seat of amputation but because of lung metastases which cannot be prevented by disarticulation. I have seen cases in which midthigh amputation in osteogenic sarcoma of the lower end of the femur was not followed by recurrence locally but by pulmonary metastases. Occasionally one is, however, misled by the roentgenogram if one depends upon it entirely in choosing the seat of amputation; since the medullary cavity may be stuffed with tumor while in the roentgenogram this portion of the bone will appear normal (Fig. 55). Here again one sees the necessity for the surgeon undertaking surgical treatment of

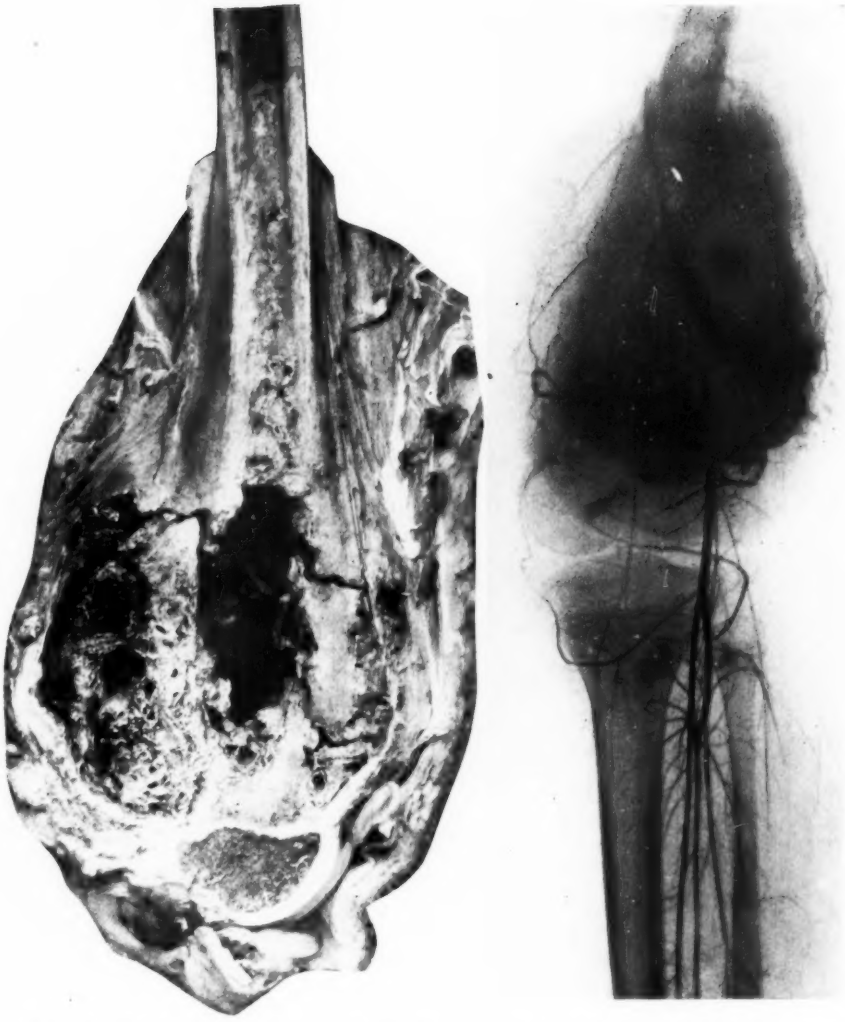


Plate 18. Case 508. Same case as that in Figure 7. Osteogenic sarcoma in a girl 5 years old. A very vascular "telangiectatic" tumor in which ligation of the afferent artery as a therapeutic measure suggests itself.

bone tumors to be well acquainted with the gross anatomy of these lesions. The ease with which an involvement of bone-marrow at the point of amputation may be overlooked explains the preference for disarticulation over amputation among surgeons years ago. Experience has shown, however, that the results

Fig. 55. Case 382. Osteogenic sarcoma in a boy 18 years old. Roentgenogram was taken 4 months after the onset; it shows an intact outline of the cortex of the bone. Disarticulation was performed at the same time and an extensive sarcomatous involvement of the medullary cavity was found; the involvement extended down past the middle of the shaft. Death 7 months after onset.

after disarticulation of the hip do not differ from amputation distal to the hip joint as far as secondary growths and recurrences are concerned. On the other hand, in exceptional instances even disarticulation is not sufficient for avoiding a local recurrence; for example, in sarcomata of the upper half of the humerus where a complete shoulder girdle extirpation (amputatio interscapulo-thoracalis) promises far better results as far as local eradication of the tumor is concerned.

The vast accumulation in recent time of technical knowledge and the advance in the application of radiation, roentgen ray and radium, in the therapy of malignant tumors in general required a re-evaluation of all accepted principles and traditions as far as the therapy of bone sarcoma is concerned. Even now clinicians are inclined to think that if a bone sarcoma is operable there is an indication for surgical treatment without losing time in radiation, while for radiation treatment only the inoperable cases are to be left. That this view is obsolete and not in accord with the disappointing results in radical surgical treatment is obvious. It is true that no astounding success has as yet been achieved by radiation therapy of malignant bone tumors and that most results here are unsatisfactory; however, the evidence on hand is encouraging, and radiation is as legitimate a therapeutic procedure in bone sarcoma as radical surgery.

Radiation therapy is still in the experimental stage, and institutions lacking the best available modern apparatus and specially qualified personnel should refrain from making wide use of it. Unfortunately we are witnessing at the present time a wide popularity of radiation therapy among persons lacking the necessary experience and skill. It is obvious that since, to the average inexperienced radiologist, the possession of an X-ray machine and radium means he is qualified to administer radiation, considerable abuse and misuse of radiation in bone tumors may be expected. Only with a vast clinical material and under prolonged, careful observation will this promising method of therapy become definite. Abuse of radiation by incompetent persons will not only greatly contribute to the confusion already overwhelming this new field of medicine, but it is also connected with great dangers for the patient. That errors in technical application of radiation may do harm is a fact fully ascertained. Whatever the true biological cause of the influence of radiation upon living tissue may be, it is attested that this action will be stimulation or inhibition depending upon the dosage together with technical factors from a detailed discussion of which I must refrain here. That inefficient radiation may stimulate the tumor growth has been emphasized repeatedly. On the other hand, over-radiation is dangerous for the normal structures of the organism. Excess of radiation may lead to ankylosis of an exposed joint. The skin becomes bronzed and leathery, and ulceration of the skin may ensue. The bones become sclerotic, ivory-like, and spontaneous fractures of such bones evince a definite delay in union. The marrow cavity becomes obliterated from over-radiation (Plate 19). Obliteration of capillaries

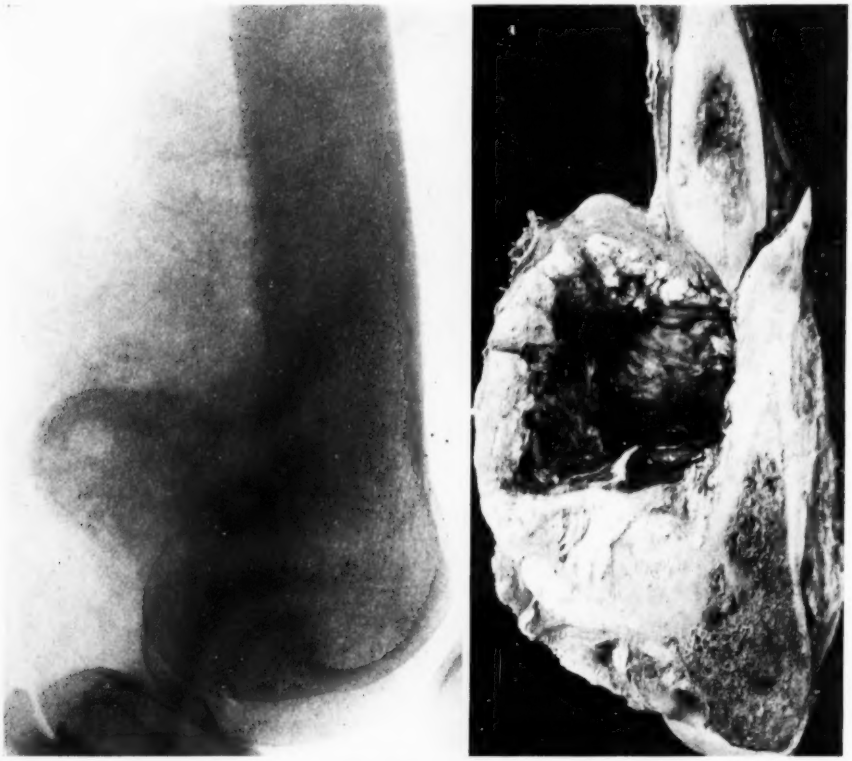


Plate 19. Case 365. Osteogenic sarcoma in a woman 25 years old. Excessive roentgen-ray radiation rendered the bone sclerotic and brittle with a pathological fracture as a result. The medullary cavity of the bone is narrowed; extensive degenerative changes in the tumor are seen, probably from radiation.

of the periosteum and endosteum causes a scarcity of callus formation in fractures. All these changes following over-radiation may be accompanied by severe pain. It is hardly necessary to argue here that in such complex biological processes as the influence of radiation upon the tumor and the organism no hard and fast rules about the dosage can exist. The reaction to radiation of similar tumors in two individuals may be very different. Only the experienced radiologist is qualified to decide the question of the dosage in each individual case. Among the various methods of application of radium the intra-tumoral application of radium recently has gained a recognized place. This procedure is hardly justified; it carries the dangers of an exploratory incision without its advantages.

The influence of radiation upon the general condition of the patient was mentioned elsewhere, as well as the influence upon the tumor itself. Radiation

leads to a conversion of a cellular tumor into a quiescent bony mass, which in large vascular tumors may contain hæmorrhagic cysts and necrotic material. In tumors with an abundant intercellular substance the response to radiation according to the present-day technique is not as effective, however, instances of calcification and ossification of the tumor combined with a retardation of growth of the tumor from radiation have been reported and are very encouraging. It is true that the cessation of growth of the tumor from radiation is merely temporary and the patient dies from local recurrence and pulmonary metastases. Thus radiation is as disappointing as radical surgery, but the difference in the sacrifice the patient has to make for radiation as compared with radical surgical treatment is enough to justify the former procedure especially since it is still in the experimental stage, when the last word has not as yet been spoken. When we learn more about the biology of radiation and acquire the same skill in administering radial therapy as we possess in using the scalpel we may hope for far better results from radiation.

The influence of radiation upon metastases is worthy of notice. I have seen cases in which the radiological evidence of pulmonary metastases has entirely disappeared from radiation and not returned for over two years; more frequently one sees pulmonary metastases kept checked by repeated radiation of the chest (Plate 20). A direct prophylactic radiation of the lungs is always indicated without regard to the method of treatment of the primary tumor whether by surgery or radiation.

Along with the rapid response to radiation of cellular and vascular osteogenic sarcomata there are some varieties which are little affected by radiation or not affected at all. To these belong tumors with a preponderance of myxomatous tissue, the skeletal chondromata and the so-called sclerosing osteogenic sarcomata. In other words, only if the tumor did not proceed in its differentiation farther than the myxomatous stage it is influenced by radiation. Moderate but persistent radiation may occasionally cause further calcification of a skeletal chondroma; radiation here leads to shrinkage of the blood supply while repeated partial surgical operations tend to increase the blood supply of the tumor. However, experience shows that skeletal chondroma of the recurring type is not suitable for radiation and should be attacked radically by surgery.

It is easy to see from the above that no generally accepted routine solution of the problem of treatment of osteogenic sarcoma is possible at the present time; and while some authoritative observers advocate amputation followed by prophylactic radiation of the lungs, others treat the patient with radiation and keep him comfortable; they think that the general comfort and well being of the patient while he is living is greater under radiation than if amputation is done. From the observations made in the foremost institutions of the country during recent years one is strongly impressed by the need of intelligent co-operation

Plate 20. Case 523. Osteogenic sarcoma. Illustrating a disappearance of pulmonary metastases after radiation. The primary tumor was in the left iliac bone in a woman 35 years old; the onset in January, 1921, an exploratory incision was made. The diagnosis of osteogenic sarcoma was proven by the extensive pulmonary metastases which were demonstrated clinically and radiologically in December, 1922. Heavy roentgen radiation was followed by a marked constitutional reaction lasting 3 weeks, after which time the lungs began to clear up. Roentgenograms taken December 26, 1922, (left) and January 17, 1923.

between the clinician, radiologist and pathologist in combating this grave disease. Without desiring to seem dogmatic I find the following way probably best in caring for a patient with a typical non-sclerosing osteogenic sarcoma. Immobilization of the extremity and recumbency are followed after a few months of efficient radiation by amputation. Moderate prophylactic radiation of the chest is to be continued throughout the whole course of the disease. It is important to avoid over-radiation. Borderline cases should be treated as typical osteogenic sarcoma. Occasionally in far advanced cases immediate amputation may give the patient a few months respite from invalidism and agonizing pain.

Prognosis

A prognosis as to life expectancy in bone sarcoma is only of relative value since the natural history of the tumors which come under observation is usually changed by surgical and other therapeutic procedures. Prognosis based solely upon results of surgical treatment is of questionable importance because many individual factors, like the type of tumor, the stage of development, individual judgment in selecting cases for surgical treatment, all have a close bearing on the final result. In general no blanket rules can be made as to the prognosis of bone sarcoma. The attempts of pathologists to form a prognosis of a tumor from its pathological and morphological features alone has nowhere failed more than in bone tumors. Now and again one sees two cases with a very similar histology, one quickly ending fatally and the other going on for a much longer period of time. The histological structure, to be sure, is important since it indicates the potential malignancy of the tumor but this is merely one link in the whole chain of circumstances which render a tumor malignant. In this chain much depends upon pure clinical evidence. Of prime importance also are the gross pathological features of the tumor; they are easier to interpret, less fallacious and therefore more reliable than the histological structure, especially in the hands of those who have had a limited experience in the histopathology of bone tumors. When in malignant bone tumors the clinical course is not in accord with the histological characteristics, this discrepancy is frequently a result of deficient study of the clinical data and the gross appearance. To be of value prognosis should be determined in the light of all data available; the clinical, radiological, and pathological. The most important points of the clinical, radiological, and pathological examination for prognosis have been emphasized in the corresponding chapters; only a few points requiring greater stress will be mentioned here.

The age of the patient with an osteogenic sarcoma is important in determining the prognosis, since adolescents are less able to withstand the disease than persons above 30 years of age. In children the prognosis is still worse because of the rapidity of growth and the early appearance of metastases. The grave prognosis in the young is well in accord with the repair-and-loss-of-growth-

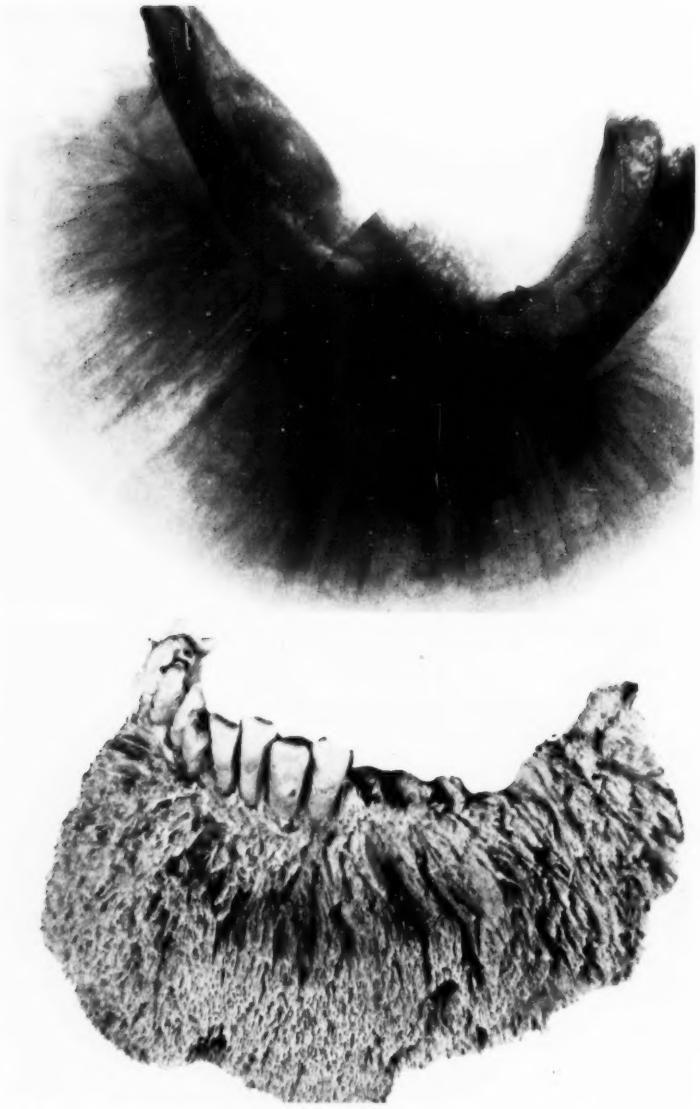


Plate 21. Courtesy of Warren Museum, Boston. Osteogenic sarcoma of the mandible. Classical roentgen-ray appearance. The photograph of the macerated and dried specimen shows the ray-like lamellæ of bone forming the skeleton of the tumor.

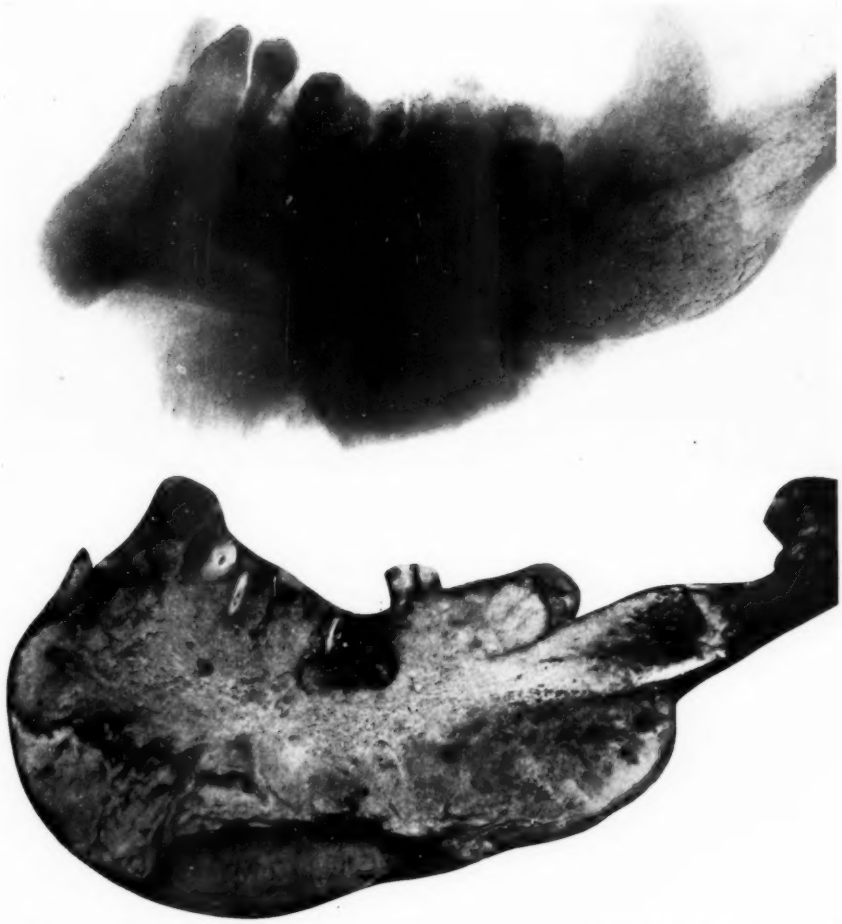


Plate 22. Case 404. Osteogenic sarcoma in a man 25 years old. Typical specimen and roentgenogram.

restraint theory of the origin of osteogenic sarcoma; if the tumor is a result of repair in the presence of a loss of growth restraint, then in the young a similar repair is far more dangerous than in the adult. The next features of prognostic importance are rapidity of growth and duration of the disease. A tumor of long standing is usually slow growing and is apt to be benign; however, the rate of growth may be entirely altered by trauma, accidental or surgical, after incomplete removal or exploratory incision. Extremely malignant osteogenic sarcomata usually are rapidly growing from the start. All other conditions being

equal, prognosis will change with the location of the tumor. The statistics frequently produced in the literature demonstrating the malignancy of a tumor in relation to its location are too dogmatic to be of real prognostic value. It is, however, sufficiently ascertained that in osteogenic sarcoma situated in or near the trunk the prognosis is very grave. Of extremities the gravest prognosis have sarcomata situated in the femoral neck. This is partly due to the thickness of the soft tissues covering the bone and consequently the late appearance of objective signs. Osteogenic sarcoma here if operated on has a worse prognosis than when situated in the upper portion of the humerus; the technical possibility of extensive removal of soft tissues infiltrated by extensions from the primary tumor is much greater in tumors of the upper end of the humerus than in the corresponding portion of the femur. The advisability of substituting the simple disarticulation of the humerus, in involvement of its upper end, by a complete removal of the shoulder girdle was mentioned elsewhere. The same operative procedure does not appreciably influence the prognosis in osteogenic sarcoma of the scapula. The indication in the recent continental literature of five years' cure in about 30 per cent of cases of "bone sarcoma" of the scapula are misleading since the authors seemingly did not discriminate between the types of tumors included in their reports. As a matter of fact, no osteogenic sarcoma of the scapula in the Registry has lived over three years after a radical removal. Of equally serious prognosis are osteogenic sarcomata of the clavicle, despite the fact that the clavicle can be easily removed without greatly impairing the function of the extremity. Sarcoma of the bones of the feet and hands are not so aggressive; they are early accessible for surgery and especially for radiation. The better prognosis here is perhaps due to the fact that a true osteogenic sarcoma of these bones is rare, most tumors here being extraperiosteal or of the surrounding soft tissue, with a fair prognosis. The osteocartilaginous tumors of the jaw are supposedly less malignant than similar tumors of long bones. This is probably due to the slower growth of the tumor in the jaw. Here recurrences after surgical removal are more frequent than distant metastases. The difficulty of removing the tumor which in the jaw is rarely well limited in a way that would insure against a local recurrence is probably a satisfactory explanation of it; recurrences are observed before distant metastases are recognized (Plates 21 and 22).

Not infrequently one is forced to determine the prognosis after the patient, operated on elsewhere, presents a recurrence or metastases. In itself a recurrence is no absolute proof that the original tumor was malignant. Incomplete removal of a benign tumor may result in a recurrence. That malignant tumors recur more frequently is largely due to the fact that a complete removal of a malignant tumor is much more difficult on account of its infiltrative growth. The presence of a recurrence in osteogenic sarcoma is not to be taken as a sign

Fig. 56. Case 271. Same case as in Figure 57. Osteogenic sarcoma. Illustrating the variety of structure in different portions of the same tumor. The shown section was taken from an area close to the periosteum.

of impending death; a fatal end is imminent but the patient may go on for months. The utmost care is necessary in determining the prognosis from a recurrence if it is ulcerated; the tufts of tumor tissue as seen after exploratory incisions are usually infected and dangerous for the basing of a diagnosis or prognosis. Usually recurrences appear in osteogenic sarcoma during the first two years; however, exceptional cases are known of recurrence after a much longer interval of time. In such instances there will always be some doubt of the true nature of the growth. In the presence of metastases the prognosis must be given with reluctance; as was mentioned elsewhere, pulmonary metastases can be kept in check for a time by radiation, and even a complete disappearance of the evidence of pulmonary metastases after radiation is known to occur.

The great importance of the date of the radiological examination for the diagnosis of osteogenic sarcoma was outlined above. Attempts were made to draw conclusions from certain radiological features of osteogenic sarcoma as to the prognosis—for example, the favorable prognosis in the so-called sclerosing sarcoma, the better prognosis in osteoblastic osteogenic sarcoma as compared

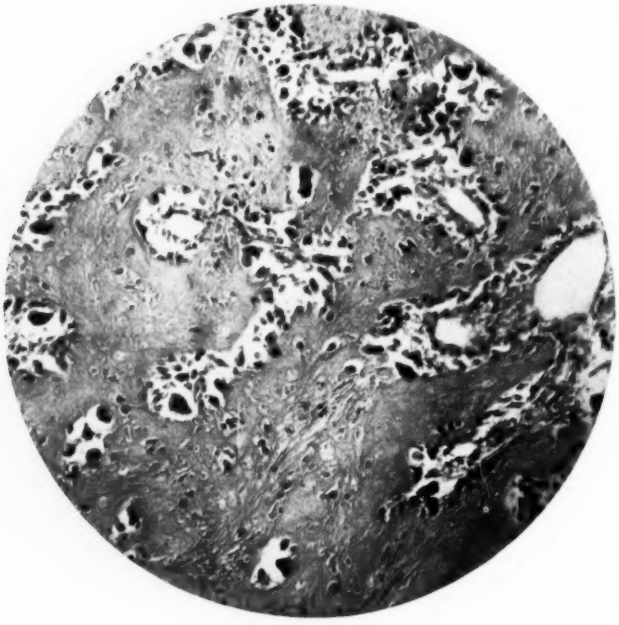


Fig. 57. Case 271. Compare with Figure 56. This section was taken from the central portion of the tumor; showing a relatively acellular hyalinized cartilaginous matrix.

with osteolytic osteogenic sarcoma when little or no ossification is seen in the roentgenogram. The utmost care is to be exercised in the prognostic evaluation of the radiological evidence. It is known how frequently a typical sclerosing osteogenic sarcoma in the roentgenogram will show numerous cellular areas; it is also generally admitted that radiation may convert a feebly osteoblastic osteogenic sarcoma into a definite osteoblastic growth in the course of several weeks. That ossification is not a dependable sign of better prognosis is evident from the fact that in the young ossification is more frequent despite the poorer prognosis than in the adult. The roentgenogram, however, is one of the most important single findings which will at once allow conclusions as to the diagnosis, stage of development, size and differentiation of the tumor.

A prognosis based upon clinical and radiological data may be greatly strengthened by findings of gross pathology and histopathology. The size of the tumor is the first factor of prognostic importance that impresses one; it is obvious that with a tumor reaching a large size without the presence of evident metastases the prognosis is better. Highly malignant bone tumors kill before they reach a large size. Encapsulation of the tumor is an important point in prognosis.

Prolonged encapsulation is a favorable sign, as very malignant osteogenic sarcomata early perforate the periosteum. Extreme vascularity of the tumor is a dangerous sign; the very vascular, so-called telangiectatic osteogenic sarcomata deserve a grave prognosis. The histological structure is an important factor in the prognosis when taken with other data, clinical, radiological, and anatomical.

The realization of the fact that the histological structure is of significance in prognosis has been greatly discredited by the assumption that all tumors may be divided in well defined groups each with an exactly defined grade of potential malignancy. The prognostic interpretation of histological findings is to be based upon the indications of the rapidity of growth of the tumor evinced by the histological structure of the tumor. The differentiation of the tumor cells is important in prognosis because an adult type of cells is usually found in the slowly growing tumors. The activity of cell division and hyperchromatism is significant as an indication of the rapidity of growth. The vascular channels and spaces lined by tumor cells characteristic of malignant sarcomata are another sign of rapidity of growth and hence of malignancy. This intimacy of tumor cells to blood vessels is important because of the readiness with which metastases may be dislodged. Necrosis if not due to radiation, is a sign of rapid growth and speaks for malignancy. Uniformity of cell structure, size and shape is a favorable sign, although pleomorphism is not an absolute indication of a grave prognosis. Tumors with a small spindle cell type have a grave prognosis.

A fact which seems to indicate a more favorable prognosis is the lymphocytic infiltration of osteogenic sarcoma. The lymphocytic infiltration was observed in 9 out of the 13 osteogenic sarcomata with five years' cure generally accepted by the Registry. The presence of the lymphocytes is not understood and involves doubt as to the diagnosis of osteogenic sarcoma in these cases; especially since the lymphocytic infiltration is rarely seen in osteogenic sarcomata which end fatally and are not incised previous to the amputation.

With the great prognostic importance of the histological structure of osteogenic sarcoma one should remember that one is not to depend entirely on the histology in deciding the prognosis if no examination of tissue from various portions of the tumor has been made; very frequently in osteogenic sarcoma one portion of the tumor differs greatly from the rest of it (Figs. 56, 57).

The few cases of osteogenic sarcoma with a five year cure in the Registry material are not sufficiently indicative to allow any general conclusions, for there is every reason to believe that the individual surgeon is more prone to register a success than a failure. On the other hand there are a large number of cases in the Registry in which the patients are still alive and have not yet reached the five year limit. Making allowances for all these arguments the very limited number of cases with a five year cure can not but greatly impress upon us the exceedingly grave prognosis of osteogenic sarcoma.

EWING'S SARCOMA

PATHOLOGY—*Gross Anatomy*

THE gross anatomy of Ewing's sarcoma is characteristic and varies from that of osteogenic sarcoma. In contrast with the latter this tumor favors the smaller bones of the extremities and the skull. When in a long pipe bone, it usually affects the shaft of the bone and not the ends. Another striking feature in which this tumor differs from osteogenic sarcoma is in the wide involvement of the shaft. The pathology of Ewing's sarcoma is less complex and easier to understand than the pathology of osteogenic sarcoma. The gross anatomic appearance in Ewing's sarcoma is mainly a result of the aggressiveness of the tumor cells, of the protective defensive measures of the affected bone, and of the regressive changes in the tumor mass. The tumor seems to begin simultaneously in numerous areas of the involved portion of the bone, in the bone-marrow filling the medullary cavity as well as the larger haversian canals. These diffusely disseminated multiple foci of tumor rapidly enlarge, become confluent, and show a great tendency to expand in all directions. The medullary cavity is frequently extensively involved at a very early stage when the cortex appears grossly intact. Fighting for space in the haversian system, the tumor diffusely dissolves the cancellous bone. The tumor cells readily spread between the bone lamellæ, which they separate and push apart. As a result of this separation of the bone lamellæ the tension and pressure lamellæ of the involved portion of bone stand out clearly in the roentgenogram (Fig. 58). This separation of the bone lamellæ causes the bone to appear in the roentgenogram thicker than normal, as if œdematous. At a very early stage of growth of the tumor the resemblance of the bone involvement to osteomyelitis is surprising (Plate 23). The resistance of the cortical bone is soon overcome by the tumor cells which rarefy and diffusely dissolve the bone from within the numerous haversian canals. With the approach of the tumor cells to the outside of the bone the periosteum proceeds to its protective reaction. A shell of new formed bone appears as a reinforcement to the bone reduced in strength. Soon the tumor cells penetrate this advancing layer of bone and spread along its external surface. A new layer of bone is laid down by the periosteum. Shell after shell of newly produced bone is permeated by the tumor until finally the periosteum is overcome in its race with the tumor and the tumor perforates the periosteal investing capsule and begins to infiltrate

Fig. 58. Case 385. Same case as that in Plates 26 and 27. Ewing's sarcoma in a boy 8 years old. This roentgenogram was taken 1 year after the onset. Showing the separation of the tension and pressure lamellæ of the involved os calcis.

the soft tissues about the affected bone. The spreading of the tumor through the haversian system with the gradual destruction of the affected bone and the newly formed bony onion-like layers parallel with the shaft, result in the characteristic diffuse displacement of the bone by the tumor mass. To this are added the occasional foci of calcification seen in the tumor. Along with forcing its way through the bone the tumor shows a great tendency to spread up and down the shaft. The very rapid growth of the tumor in some instances prevents the periosteum from forming a true bone shell and the periosteum is pushed away by tumor tissue; when the latter has undergone necrosis it leaves a cavity running beneath the periosteum up and down the shaft. Necrotic liquefied tumor tissue occasionally resembling gross pus may fill the cavity.

The consistency of the tumor depends somewhat upon the stage of growth and the regressive changes which have taken place in it. In the very early stage of growth when the tumor is grossly limited to a relatively small area of bone the tumor presents a soft mushy white grayish substance pressed into the empty

Plate 23. Case 161. Ewing's sarcoma in a boy 13 years old. The roentgenogram and specimen show the condition 3 weeks after the onset. Notice the onion-like layers in the roentgenogram and the diffuse involvement of the bone-marrow, with a permeation of the cortex by the tumor.

spaces resulting from focal bone absorption. It resembles the appearance which one encounters in osteomyelitis with granulation tissue filling up the chambers between the necrotic bone trabecula. In later stages of growth when only traces of remaining bone are seen in the tumor tissue, the tumor represents a soft medullary crumbly growth which has extensively destroyed the shaft of the bone and infiltrated the soft parts about it. This diffuse involvement of the

Fig. 59. Case 173. Same tumor as that in Plate 31. Ewing's sarcoma. Coherent pavement sheets of cells without definite structure formation.

surrounding fascia and muscles, however, may be outlined by a distinct thin pseudocapsule, which disappears at the advanced stage of the tumor. The only supporting stroma of this very cellular brain-like tumor mass are strands of coarse connective tissue ramifying in the tumor and subdividing it into lobules.

The consistency of the tumor greatly depends upon its vascularity. While the blood supply here does not reach such extremes as in osteogenic sarcoma, still the degree of vascularity differs enough in various cases to influence the consistency of the tumor. As in other cellular tumors, regressive changes are not uncommon in Ewing's sarcoma. Necrosis in tumor areas with liquefaction may greatly resemble gross pus. In some instances such regressive changes may result in cystic formations with yellow or red jelly-like contents.

Structure

Unlike that of osteogenic sarcoma the histology of Ewing's sarcoma is simple. The type cell is small polyhedral with round oval or slightly elongated nucleus with scant clear stainless cytoplasm. The nucleus is slightly stained with scattered chromaffin granules and nucleoli which are not distinguishable or are hardly so.

Fig. 60. Case 267. Ewing's sarcoma. Showing hydropic degeneration of the tumor cells.

The cytoplasm frequently simulates a syncytium. While mitoses are abundant it is a striking feature that no tumor giant cells are seen here, the cells containing a single nucleus. The cells are extremely uniform, no pleomorphism being observed. The arrangement of the tumor cells is peculiar. Coherent pavement sheets of cells without any definite structure formation in the various sized lobules is the most frequent finding (Fig. 59). Not infrequently one encounters mucoid or hydropic degeneration of the tumor cells (Fig. 60). Complete necrosis with liquefaction is not uncommon. Frequently in section the cells are seen so close to one another as to influence the shape of the cell. A not uncommon finding is the arrangement of tumor cells about blood vessels, arterioles and capillaries (Fig. 61). An opinion has even been ventured that the blood vessels present a structural unit of Ewing's sarcoma. While the tumor cells sometimes appear arranged like a mantle about cross sections of blood capillaries, there is no evidence to support the view that, in this, Ewing's sarcoma differs from other cellular sarcomata with the so-called perithelial or perivascular arrangement. Disintegration of the tumor cells far from blood vessels leads to this appearance in any rapidly growing cellular tumor. The so-called perithelial arrangement is therefore not a necessary sign of Ewing's sarcoma, although a common one.

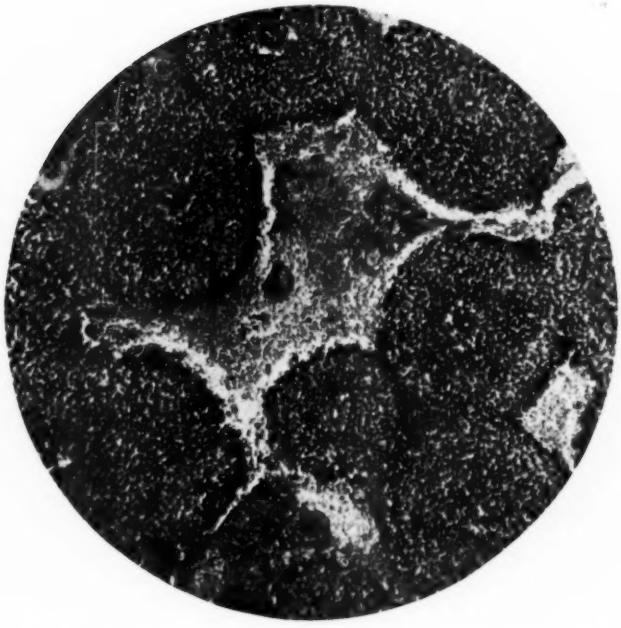


Fig. 61. Case 364. Ewing's sarcoma. Arrangement of tumor cells about arterioles and capillaries.

A striking feature of Ewing's sarcoma is the complete absence of intercellular substance. The syncytial stainless cytoplasm of the tumor cells occasionally leads one to an erroneous conclusion that the cells are embedded in an intercellular substance, but no definite cell borders can be made out there. This syncytium caused observers to suggest œdema of the tumor cells; however, the same occurrence is seen in well fixed Zenker preparations. In some spots thrombi of agglutinated red cells, and eosin staining globuli simulate intercellular matrix. Another source of error as to the presence of intercellular substance arises in connection with the hyalinized blood vessel walls supplying the tumor. Usually the eosin stained homogeneous ring of the cross section of the blood vessel wall separates the tumor cells packed around it from the lumen filled with intact blood and lined with normal endothelium (Fig. 62). In tangential longitudinal sections the blood vessel wall will readily form trabeculæ of hyalinized homogeneous connective tissue lined with rows of tumor cells (Fig. 63). These homogeneous rings and strips have been erroneously interpreted as an intercellular substance of the tumor cells. In reality these collagen fibers are not produced by the tumor cells. The tumor cells in Ewing's sarcoma do not produce anything;

Fig. 62. Case 515. Same tumor as that in Figure 63. A homogeneous ring in the cross section of the wall of the blood vessel separates the tumor cells from the lumen of the blood channel.

in this respect they seem to be far more primitive than the tumor cells in osteogenic sarcoma, if indeed any analogy may be drawn between them.

The histological picture of Ewing's sarcoma is somewhat complicated by the reaction of the tumor on the osseous tissue of the affected bone. As pointed out above, diffuse bone absorption is one of the characteristic features of Ewing's sarcoma. The extensive absorption of the shaft is accomplished without the help of giant cells. In sections one frequently sees bone trabeculæ with typical morphological features of necrotic bone closely surrounded by tumor cells. The new formed bone is of both neoplastic and metaplastic variety. Along with areas of well formed lamellary bone close to the periosteum one encounters islands of new formed bone of low grade quality in the neighborhood of the tumor cells (Fig. 64). Since the tumor cells in Ewing's sarcoma do not form any intercellular substance, this bone is doubtless a product of a regenerative process of the affected bone. This is another proof that the distinction between well formed lamellary reactive bone and trabeculated low grade tumor bone is unsound.

The typical histological structure of Ewing's sarcoma is not infrequently accompanied by peculiarities which are apt to complicate it somewhat. To these

Fig. 63. Case 515. Compare with Figure 62. Ewing's sarcoma. Showing a tangential section of the wall of a blood vessel surrounded by tumor cells. Notice the trabeculæ of the hyalinized homogeneous connective tissue of the wall.

belongs the admixture of plasma cells. This fact suggests the question of the relationship between Ewing's sarcoma and a plasma cell myeloma, a question which must be left in abeyance because of our present lack of knowledge of the origin of myelomata in general. A generous admixture of blood cells and bone marrow elements may still further complicate the appearance. As in osteogenic sarcoma one meets in Ewing's sarcoma also with an occasional lymphocytic infiltration. This infiltration when present is usually observed in the peripheral portions of the tumor where tumor frequently appears to consist of tissue truly indistinguishable from inflammation in the bone. Because this reaction is especially marked in the periphery of the tumor, one readily understands how an exploration here will lead to an erroneous diagnosis of inflammation. The admixture of these numerous cellular elements to the tumor cells often so complicates the picture that the tissue, after passing through poor technical preparations, is difficult to distinguish from myeloma or inflammatory lesions of bone.

Generalization of Ewing's sarcoma with metastatic growths elsewhere in the body proceeds through the blood and lymph stream, favoring the lymph stream

Fig. 64. Case 292. Ewing's sarcoma. Low-grade newly formed bone is seen in the close proximity of tumor cells.

more frequently than osteogenic sarcoma. Metastatic involvement of regional lymph nodes in Ewing's sarcoma is not infrequent. Unlike osteogenic sarcoma, Ewing's sarcoma is apt to metastasize to other bones of the skeleton and especially to the skull. The lungs and skull with the scalp are the most frequent seats of a metastatic Ewing's sarcoma. The metastatic foci in bone repeat all the characteristic features of Ewing's sarcoma and especially the diffuse bone absorption. The solid cellular growths occurring in skeletal and pulmonary metastases show a greater tendency to regressive changes than is the case in osteogenic sarcoma. While occasional calcification of a degenerated area in a metastatic focus has been observed, true bone formation does not occur in metastases of Ewing's sarcoma. This fact is also important proof that the origin and the physiology of the tumor cell in Ewing's sarcoma is at great variance with that of osteogenic sarcoma.

There has been noticed an attempt on the part of men defending Ewing's viewpoint of the endothelial nature of Ewing's sarcoma (Connor) to subdivide this tumor into various types. They based this subdivision upon the relation of the groups of tumor cells to the adjoining blood vessels. They describe angio-endothelioma as a variety of Ewing's sarcoma, when the tumor cells become

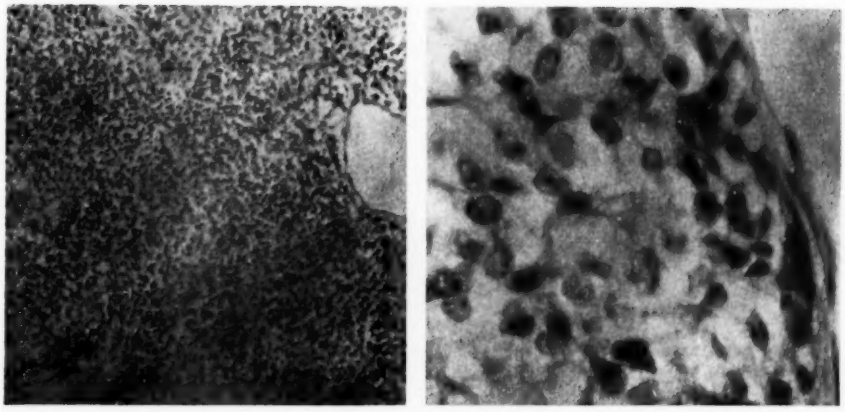


Plate 24. Case 326. Ewing's sarcoma. Showing the normal endothelium lining the blood channels surrounded by tumor cells. Low and high magnification.

flattened approaching the normal vascular endothelium and forming blood vessels and sinuses and showing a perithelial arrangement. That the so-called perithelial arrangement is not a specific feature of Ewing's sarcoma and is not infrequently observed in any rapidly growing cellular tumor has been previously stated. The presence of blood in spaces between tumor cells is no evidence that these tumor cells have been acting as a vascular unit; it is too well known with what ease a hæmorrhage may take place in a loosely arranged conglomeration of tumor cells. The attempt to interpret the tumor cells surrounding the blood cells as a vascular lining is in extreme discord with repeated statements of Ewing himself that the vascular endothelium has no relation to the origin of Ewing's sarcoma (Plate 24). An angio-endothelioma is a tumor of the vascular endothelium. It is characterized by the large cuboidal or cylindrical cells with clear cytoplasm and sharp cell membrane which constitute it. The clear cut difference between these cells and the type cell in Ewing's sarcoma is obvious. Ewing distinctly discriminates between angio-endothelioma of bone and the diffuse endothelioma (Ewing's sarcoma). Not only the histology but also the clinical behavior, the roentgenological picture and the prognosis of angio-endothelioma is different from Ewing's sarcoma. There can be no doubt that such a confusion of angio-endothelioma with Ewing's sarcoma is against all the present knowledge and evidence on hand and is misleading.

A most interesting point in the pathology of Ewing's sarcoma is the question of the origin of the tumor. While almost all who have had the opportunity to study the collection of Ewing's sarcomata in the Registry material agree that this is a specific disease, not all are willing to accept Ewing's contention that the tumor originates from the perivascular endothelium. As in any other rapidly

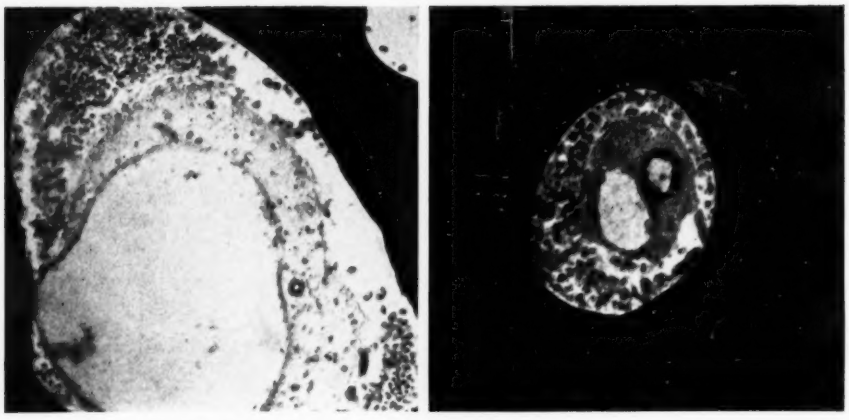


Plate 25. Case 418. Same case as that in Figure 68. Ewing's sarcoma. Minute foci of tumor cells arranged perivascularly in the haversian canals.

growing malignant tumor it is difficult to arrive at a conclusion about the origin of the tumor in the more or less advanced stages of growth, from observation alone. In the Registry material cases of Ewing's sarcoma are encountered in various stages of growth and those in the very early lesions may suggest the possible origin of the tumor. In one or two of these tumors in early growth one finds in the periphery a sprinkling of minute foci of tumor cells arranged perivascularly in the haversian canals (Plate 25). The normal presence here of perivascular lymphatics and vasa vasorum would seem to suggest that the cells originated about these anatomical structures. The nearer they are to the main tumor mass, the larger and the more numerous the foci become, and finally they merge with the main tumor mass. Whether these accumulations of tumor cells originate in the spaces where they seem to lie or whether they are brought here in the lymphatics from the main tumor, is a subject for speculation. The nature and the origin of these cells cannot be asserted positively even in these locations seemingly most favorable for study. Ewing feels that the cells of Ewing's sarcoma are "to be assigned to some endothelial category, and it may be that the interpretation of 'endothelium' may have to be widened to include this group. I do not think they arise from blood or vascular endothelium. They may possibly arise from perivascular lymphatic endothelium.[1]" Considerable argumentation of purely hypothetical character was brought in support of Ewing's hypothesis of the endothelial origin of Ewing's sarcoma. However, all these considerations are both questionable and unavailing in the absence of sufficient evidence in favor of this hypothesis. The difficulties in deciding this question of origin are great. One doubts whether morphological studies alone will ever successfully

[1]Ewing, James. Endothelial myeloma of bone. Proc. New York Path. Soc., 1924, xxiv, 93.

solve this problem. As in other tumors the essential experimental link in the chain of evidence is lacking here.

The clinical and pathological concept of the disease invites some theoretical speculations. In the face of the evidence accumulated from our study of this condition one is justified in expressing a suggestion of the probable constitutional nature of this disease. The relation of Ewing's sarcoma to lymphogenous disturbances is very suggestive. In this respect it is of significance that on the outskirts of Ewing's sarcoma there is evident an absence of blood forming elements in the bone-marrow. That Ewing's sarcoma is more than a simple bone tumor is evidenced by the diffuseness of involvement and the multiplicity of foci of origin in the same bone and also by the appearance of multiple tumors frequently very early in the course of the disease. One rarely sees a malignant tumor where the primary and secondary involvement appear almost simultaneously.

Clinical Course

The history and the clinical course of cases of Ewing's sarcoma are characteristic enough to allow a distinction between them and other bone tumors and are of great importance in the diagnosis of this disease. This fact is not yet appreciated and, as in osteogenic sarcoma, the clinical history is not given the deserved interest and attention.

The clinical incidence and frequency of Ewing's sarcoma may be judged from the fact that in a series of about 650 cases of bone tumor which have been submitted to the Registry as "bone-sarcoma" there were 40 instances of Ewing's sarcoma. If to these 40 cases one adds 10 others of more or less doubtful nature, but greatly resembling Ewing's sarcoma, one obtains the frequency of Ewing's sarcoma as 7.5 per cent of all instances diagnosed by the average operating surgeon as "bone sarcoma." In Ewing's sarcoma the male sex distinctly predominates, there being about three times as many males affected as females. In this respect Ewing's sarcoma resembles also skeletal myeloma which affects decidedly more frequently males than females. Ewing's sarcoma differs from myeloma and approaches clinically osteogenic sarcoma by the age incidence. While myeloma is encountered mostly in the fourth and fifth decades, Ewing's sarcoma falls in the last half of the first and the first half of the second decade of life. Of 40 typical Ewing's sarcomata in the Registry material 20 cases were observed in patients of the age between 6 and 15 years and only 3 cases after the age of 40. It is of interest to note that among the patients with Ewing's sarcoma some are very delicately built with slim graceful long bones, while others are fat with evidence of endocrine disturbances.

Ewing's sarcoma differs greatly from osteogenic sarcoma in location. The long pipe bones are the favored seat of the disease, but the most frequently involved bone is the tibia, next in frequency are the fibula, humerus, ulna, and

then the femur. In distinction from osteogenic sarcoma Ewing's sarcoma is a not uncommon affection of the clavicle, of the small bones of the feet, the ribs, vertebræ, mandible, and skull. The bones of the shoulder girdle and of the pelvis are all represented among these cases. The most striking feature of Ewing's sarcoma is that the site of predilection is the shaft and not the epiphyseal ends of the long bone. The involvement extends over a wide area usually more than half the length of the bone and occasionally an involvement of the entire shaft is encountered. Apparently the epiphyseal ends of a long bone are not absolutely immune to Ewing's sarcoma and occasionally one sees a Ewing's sarcoma affect the end of the bone. However a Ewing's sarcoma never proceeds as close to the end of the bone as does an osteogenic sarcoma. When a Ewing's sarcoma affects the spine, more than one vertebra is usually involved. The fact that the involved vertebræ are usually adjoining one another would seem to remove all possible doubt as to whether the involvement of all vertebræ is primary or whether some are metastases from the primary. This question of whether a multiple Ewing's sarcoma represents a true multiple primary involvement or merely metastases from one primary is even of more importance in Ewing's sarcoma than in osteogenic sarcoma. As was mentioned, a simultaneous osteogenic sarcoma of more than one bone is a curiosity, while in Ewing's sarcoma this is rather a characteristic feature of the disease (Plate 26). In the advanced stage most cases of Ewing's sarcoma reveal multiple lesions in the skeleton. Such tumors occur almost constantly in the skull and frequently in the extremities and ribs. This question is obviously of significance because of therapeutic considerations, since if the tumors are multiple there is a contra-indication to amputation while if they are metastases there is a vital indication for early aggressive radical treatment. It would seem that the extensive occurrence of skeletal tumors in advanced stages of a Ewing's sarcoma with the relative integrity of other organs points to the probability that the tumors are truly multiple and not skeletal metastases.

A frequent point in the patient's history is previous trauma at or near the seat of the tumor. The significance of trauma as an etiological factor in Ewing's sarcoma is open to the same speculations and objections as in osteogenic sarcoma, however in Ewing's sarcoma the history of trauma combined with the complaints of pain and fever, as described above, sidetracks the physician toward an erroneous diagnosis of osteomyelitis. Pain is an important and constant component of the patient's history. In distinction from pain in osteogenic sarcoma pain in Ewing's sarcoma is of a more intermittent character. Frequently the incipient pain after the trauma subsides, and the injury is entirely forgotten until an attack of sharp pain in the affected region combined with a febrile reaction reminds the patient of the trauma. The incipient attack lasts a few days and several months may pass before another attack occurs, while any

Plate 26. Case 385. Same case as that in Plate 27 and Figure 58. Ewing's sarcoma in a boy 8 years old. Death 18 months after the onset. A diffuse involvement of most of the bones of the skeleton. The tumor first arose in the left os calcis. Notice the grossly intact outline of the femur while the medullary cavity is extensively involved.

localizing symptoms may be completely absent. Each succeeding attack is of longer duration and of greater severity, and the intervals between the attacks constantly grow shorter, until finally the pain becomes of a permanent rheumatoid character. Usually at this stage a distinct tumor growth is recognized on palpation. It is not unusual to see a patient with Ewing's sarcoma up and around for more than a year, suffering from intermittent pain and attacks, before being confined to his bed. The fever accompanying the attacks may be of considerable severity. The febrile attacks throughout the course of the disease suggests that the tumor is essentially a lesion of the bone-marrow. The blood findings are of very little significance; however, not infreqeuntly it also points toward an inflammatory disturbance. The leucocytes may number 12,000 to 15,000, maintaining the normal relationship in the differential count. In far advanced cases a typical picture of secondary anæmia is present. It is easy to see how repeated attacks of fever and pain some months before tumefaction is revealed, all preceded by a trauma, lead the physician to an erroneous diagnosis of osteomyelitis. Frequently a patient with Ewing's sarcoma is operated on under a diagnosis of osteomyelitis, some are even operated on repeatedly with this diagnosis, which is also suggested by the pathologist's report of the examination of the tissue removed.

The skin overlying the bone remains free from involvement save in rare instances in far advanced stages of the disease. A surgical exploration of the tumor usually leads to a continuous ulceration with large fungous growths protruding through the incision. However a healed exploratory wound is not to be looked upon as a point against a malignant tumor since complete or temporary healing of such exploratory incisions do occur. Palpation is an important aid in the diagnosis of Ewing's sarcoma. Palpation allows one to determine the general outline of the tumor, its wide extension along the involved bone and its consistency. Repeated palpation is of primary importance when radiation is used as a diagnostic therapeutic test; one is surprised how easily the changes in outline, size and consistency of a Ewing's sarcoma subjected to radiation therapy can be perceived by palpation. Palpation may early reveal the response of the regional lymph nodes to the disease. An enlargement of the regional lymph nodes here is of even more significance than in osteogenic sarcoma, since here this is frequently not only an inflammatory enlargement but a true metastatic involvement.

The first appearance of the tumor and its further progress are rather peculiar. As mentioned above, the first febrile attacks are of more general constitutional character and no localizing is present. The tumefaction arises suddenly with signs of local hyperæmia and inflammation. After the febrile attack and most symptoms of general malaise subside, a tumor is discovered. At commencement the tumor may be slow in progress; it may also entirely subside and disappear,

merely to return with a subsequent attack in a considerably larger size. Then the growth becomes continuous and increases rapidly in size before the termination. The incipient temporary variations in size of the tumor often lead the patient and not uncommonly also the physician to an erroneous conclusion of a spontaneous cure. The patient keeps up his daily work until a new attack finally leads to a persistent tumor. Pathological fractures are not typical of Ewing's sarcoma, save in the terminal stage of the disease. Joint involvement is unknown in Ewing's sarcoma for obvious reasons: that the shaft is involved instead of the ends of the bone and that Ewing's sarcoma does not proceed to the articular cartilage.

The terminal stage of Ewing's sarcoma is different from that in osteogenic sarcoma, although it is necessary to admit that our knowledge of the final stage of the disease is much less accurate. As a general rule the patient is taken home before termination where he remains until death; necropsies of such patients are scarce. The generalization period cannot be set accurately since metastases are apt to show up on one hand in such a short interval of time as a few months after the appearance of the primary lesion, and on the other hand years may pass before metastases are found. The advent of metastases is frequently accompanied by severe febrile disturbances, especially in pulmonary involvement. Frequently the first organ to show a metastatic involvement is the skull. After the appearance of the first secondary tumor, the disease may again become stationary for some period of time especially after radiation. Months or even a year may pass before pulmonary metastases reveal themselves and secondary tumors in other bones appear. The patients are usually greatly emaciated at this stage of the disease and soon die. Metastases to the regional lymph nodes are not uncommon in Ewing's sarcoma although they are far behind the skull and the lungs in frequency. From the scarcity of evidence which it has been possible to obtain at necropsy, it seems that metastases to other soft organs are not frequent. In several cases an extensive involvement of the kidneys, liver, and spleen were observed (Plate 27).

Summarizing the average history and clinical course of a patient with Ewing's sarcoma, the most striking features are—trauma followed by intermittent pain of long duration, tumefaction, and diagnosis of osteomyelitis. When in a young person a seemingly trivial trauma is followed by an insidious onset of fever and intermittent limping due to a recurrent aching bone and is accompanied by a slight or no increase in leucocytes a tumor is more probable than is osteomyelitis. The following is a history of Case 538 of the Registry, unanimously accepted as Ewing's sarcoma. The history is a good illustration of a typical course of Ewing's sarcoma and also of the errors in diagnosis which are apt to accompany this tumor. Only by realizing how easy it is to make similar errors in this disease can such errors be avoided.

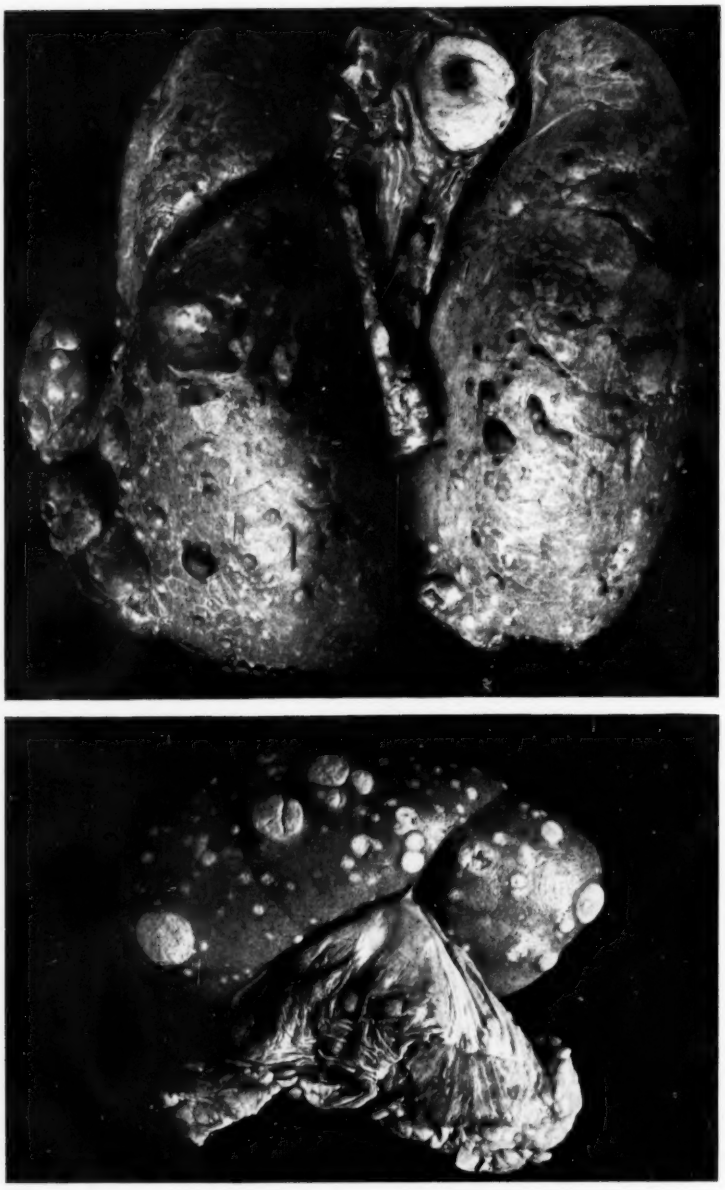


Plate 27. Case 385. See Figure 58 and Plate 26. Ewing's sarcoma. Visceral metastases.

Case 538. A boy 6 years old sustained an injury to the left leg below the knee by falling down steps. He limped and complained of pain for about a week after the accident, with fever at night. Ten days after the trauma he was seen by a physician; his temperature was 102 degrees F., pulse about 140, and leucocytosis 12,000. A roentgenological examination showed an area of absorption along the medullary canal of the tibia about 4 inches below the proximal articular end, the bone showing a definite periosteal reaction. A diagnosis of osteomyelitis was made and the patient was operated upon immediately. A hole was chiseled into the marrow cavity and a small "pus cavity" was curetted. A silver wire drain was inserted and the incision closed. The pathologist's diagnosis was "subacute osteomyelitis; pus sterile." An uneventful convalescence followed; the incision healed and the temperature dropped to normal in about 3 days. About a month later pain returned with slight fever. An examination showed the affected area in the tibia to have increased slightly in size. Nothing was done at this time. Two months later the patient was brought back with severe pain in the leg. There was localized tenderness and swelling in the neighborhood of the old operative wound. The history at this time revealed that several days previously he began to complain of soreness and pain in the leg and of fever. He walked with perceptible limp but the knee joint showed no disability. He was readmitted to the hospital with a temperature of 100 degrees F. and leucocytosis of 15,000. At this time the roentgenogram showed the absorption in the medulla and the periosteal reaction more pronounced than before (Fig. 65). A second operation was performed. Through the old incision the hole in the bone was enlarged upward toward the tibial tubercle where a "large pus pocket was found containing yellowish-red pus." The marrow cavity was curetted radically until "hard healthy bone was found on all sides, bone cavity wiped out with phenol and alcohol." The incision was again closed with a wire drain, *in situ*. The pathologist's diagnosis was "subacute osteomyelitis, agar and broth cultures of pus showed no growth."

Fig. 65. Case 538. Same case as that in Plate 30. Ewing's sarcoma. The clinical history of this case is given in the text. The roentgenogram was taken before the second exploratory operation. A careful interpretation of the roentgenogram would have suggested a diagnosis of tumor at this stage while histological examination of the curettings continued to sidetrack the diagnosis for another 14 months.

About a year after the first onset of pain there was no improvement clinically in the patient's condition. The leg continued to be painful at intervals accompanied by an occasional rise in temperature. The roentgenogram at this time showed the area of destruction in the medullary canal to be about five times its size at the first operation. The neighboring bone and the medulla showed irregular deposits of calcium and an occasional area of absorption. The cortex posteriorly was partially destroyed. There was no involucrum formation. The diagnosis at this time was "osteomyelitis, probably tuberculous." Sixteen months after the first onset of pain the leg was again examined and showed no improvement clinically and a further destruction of the cortex. There was some fraying of the periosteum at the ends of the apparent involvement of the bone. Eighteen months after the first onset of pain the patient returned for roentgen-ray examination. Numerous small rarefied areas of absorption were seen throughout the bone. Plaster cast was applied. Twenty-two months after the onset of the disease the roentgenogram first raised a suspicion of malignancy. Considerable calcified material was thrown out and a soft tissue tumor surrounding the bone was seen. At this time a sinus was curetted to secure tissue for histological examination. Pathologist's report: "Typical lymphoid cell granulation tissue with one spot of tumor tissue infiltrating the granulation tissue." Following the application of a new cast a profusion of fungus-like "granulation tissue" suddenly bulged out through the window in the cast. At this time the patient was 8 years old, the duration of the illness being 2 years; he was running a septic temperature and suffering great pain. The hæmoglobin was 70 per cent, red cells numbered 2,600,000, leucocytes 9,000. The wound was again curetted for a histological diagnosis. The pathologist reported: "The diagnosis rests between sarcoma and granulation tissue; there are very cellular areas suspicious of sarcoma." Radiation therapy was started on the left leg, on the lungs, and on all other bones except the skull. Two weeks later the circumference of the left leg had become reduced from 30.25 centimeters to 27 centimeters. The granulations became of a healthy appearance; the temperature became normal, and the pain entirely disappeared. A month later radium treatment was given. The child's condition improved rapidly; he gained 3 pounds. Two months later "removal of large sequestrum was thought advisable." Sequestra were removed with a large quantity of necrotic soft tissue. Microscopically there was "no positive evidence of sarcoma." A month later after the last operation the child developed headaches; roentgenological examination of the skull showed numerous sarcomatous metastases; there was no indication of metastases in the lungs or ribs. Radiation therapy to the skull soon relieved the headaches and the general condition was fairly good. Treatment was continued for 3 months after the skull metastases were discovered, when the left leg again began to pain. The general condition of the child became poor, the granulation tissue had again piled up and acquired a foul odor, and the patient died 2 months later, 2 years and 10 months after the first onset of pain.

Diagnosis

In studying Ewing's sarcoma, one is especially impressed by the danger of an overestimation of the roentgenological method of examination on one hand and an exaggeration of the diagnostic possibilities of histological examination alone on the other. In all skeletal tumors but especially in Ewing's sarcoma if one attempts to base a diagnosis on the roentgenogram alone one will frequently be mistaken, but to satisfy oneself in the establishment of a diagnosis by a histological examination alone is not less erroneous. Only a well-planned and carefully conducted analysis of the history and clinical picture together with a study

of the findings of the radiological and pathological examination will reduce *ad minimum* the errors in diagnosis. In the presence of Ewing's sarcoma the clinical history and findings as outlined above will frequently suggest the diagnosis. Among the salient features in the clinical history of the disease, trauma has a definite place. Whatever the true causative relation of trauma to Ewing's sarcoma may be it is significant for diagnosis that trauma is commonly present in the history. Next in succession to trauma are the intermittent symptoms, with apparent complete disappearance of trouble merely to return in a more severe form.

As a rule the periodically aching bone, historically following after a trauma, together with a general constitutional response, leads to a diagnosis of osteomyelitis. This error is so frequent that it is in itself a characteristic feature of Ewing's sarcoma. The findings of the subsequent early radiological examination are not incompatible with osteomyelitis. This diagnosis may be supported by the gross appearance and frequently by the histological examination of "granulations" removed during an attempt at curettage and drainage of an osteomyelitic process. Finally, after the surgical intervention the intermittently progressing tumor begins to grow rapidly and soon the error in diagnosis is exposed. The fact that osteomyelitis is almost a typical error in diagnosing Ewing's sarcoma is not surprising when one realizes how much in common these two conditions have in a superficial examination. The triad of clinical symptoms of Ewing's sarcoma, the history of trauma, intermittent pain in a bone, and the signs of inflammation greatly resemble the triad of osteomyelitis,—intermittent boils, trauma, and pain in the bone. The slow progress of the disease and the usually not very prominent constitutional reaction suggest a chronic, slowly proceeding osteomyelitis; an acute inflammation is rarely considered. In this respect Ewing's sarcoma differs from osteogenic sarcoma when an acute or subacute osteomyelitis is not infrequently erroneously considered. The not uncommon sudden onset of pain in osteogenic sarcoma accompanied as it may be by inflammation of the skin, fluctuation or pseudofluctuation and fever is a satisfactory explanation of this divergence between Ewing's sarcoma and osteogenic sarcoma. The frequency of mistaking a malignant bone tumor for osteomyelitis suggests that no diagnosis of a chronic inflammatory skeletal process should be made before the probability of a malignant tumor is considered and ruled out. On the other hand it is not unusual to observe an erroneous consideration of osteomyelitis as Ewing's sarcoma or osteogenic sarcoma. Cases are known in which radical surgery led to amputation of a limb because of such mistaking of osteomyelitis for a malignant tumor. Such errors were more frequent before modern diagnostic radiology was known. Especially suspicious in its resemblance to osteolytic osteogenic sarcoma is a central osteomyelitic abscess, so-called Brodie's abscess; its usual location in the metaphysis is not incompatible

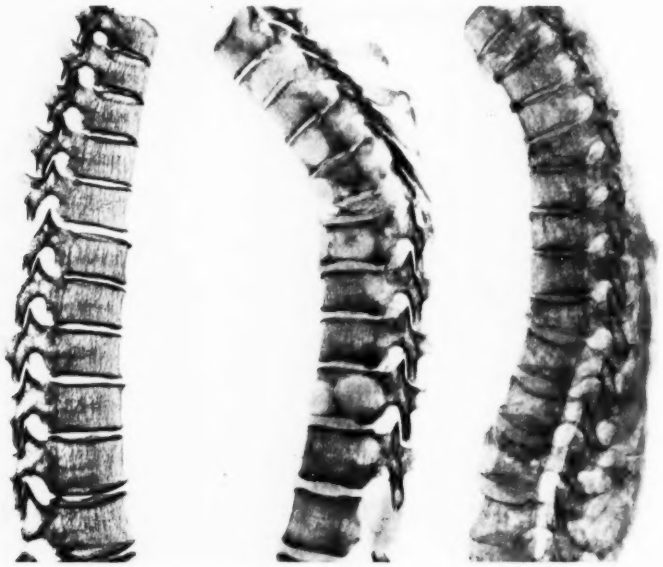


Plate 28. (1) Normal spine, (2) metastases of a carcinoma of the breast, (3) myeloma of the spine.

with osteogenic sarcoma. However in the roentgenogram it differs from osteogenic sarcoma in the sclerosing osteitis and periostitis surrounding the lesion, features absent in osteogenic sarcoma.

A tuberculous skeletal involvement is considered chiefly in tumors of the spine. Here mostly Ewing's sarcoma is concerned, because of the favorite seat of Ewing's sarcoma in the vertebræ. A careful analysis of the clinical findings will greatly help a differentiation. Thus sensory and motor disturbances are a much earlier complication in Ewing's sarcoma than in tuberculous spondylitis. The absence of cold abscesses in advanced stages of the disease also speaks for tumor. Another differentiating point has been described in the literature: Œdema of the soft tissues overlying a vertebra which is the seat of a malignant tumor. Most important for the differentiation is the roentgenogram. It should be realized, however, that it will be disappointing to expect findings which would warrant a diagnosis from a large film where most of the spine is exposed. The suspected area of the spine, not more than 3 to 5 vertebræ, should be exposed on one film so that they all lie in the direction of the central rays.

Experience has shown that interpretation of roentgenograms of the spine are little understood by the average clinician; the fundamentals of the normal appearance of the spine in the roentgenogram are not generally known. In a roentgenogram of a normal vertebra one notices two systems of bone trabeculæ

which intersect perpendicularly and which are interrupted in their continuity by a sagittal canal carrying the main central vein of the vertebra. Most important is the fact that the height of each caudally following vertebra is larger than, or at least of the same size as, that of the one above it. A longitudinal diameter of a vertebra shorter than the corresponding diameter of the vertebra above it is to be considered as absolute indication of a pathological involvement of the vertebra. It is hardly necessary to say that the integrity of the sharpness of the outline and the uniformity of the density of a vertebra is as important diagnostically as in any other bone (Plate 28).

An important clinical symptom frequently neglected by the physician is sciatica. Sciatica may be the first symptom in tumors of the lumbar and sacral spine and the bones of the pelvis. It is also encountered occasionally in tumors of the cord as well as tumors of the soft organs of the pelvis. It is significant that with an increase of the experience of the surgeon the incidence of idiopathic sciatica decreases.

Fig. 66. Case 267. Ewing's sarcoma in a boy 8 years old. Amputation and later application of radium to abdominal metastases (?). The patient is well 5 years after the onset. The roentgenogram was taken 5 months after the onset. The apparent widening of the shaft and the displacement of the old bone by the tumor with the extensive involvement of the shaft is typical of Ewing's sarcoma.

The differentiation of Ewing's sarcoma from osteogenic sarcoma is accompanied with difficulties. Much reliance can be placed upon the clinical history and course, but the roentgenogram is frequently so characteristic in Ewing's sarcoma that it decides the diagnosis. A roentgenogram of an early Ewing's sarcoma will show a diffuse involvement of the bone; this is probably due to a diffuse origin of the tumor throughout the haversian system. Usually the diaphysis is involved and not the ends. Of 40 cases of Ewing's sarcoma,

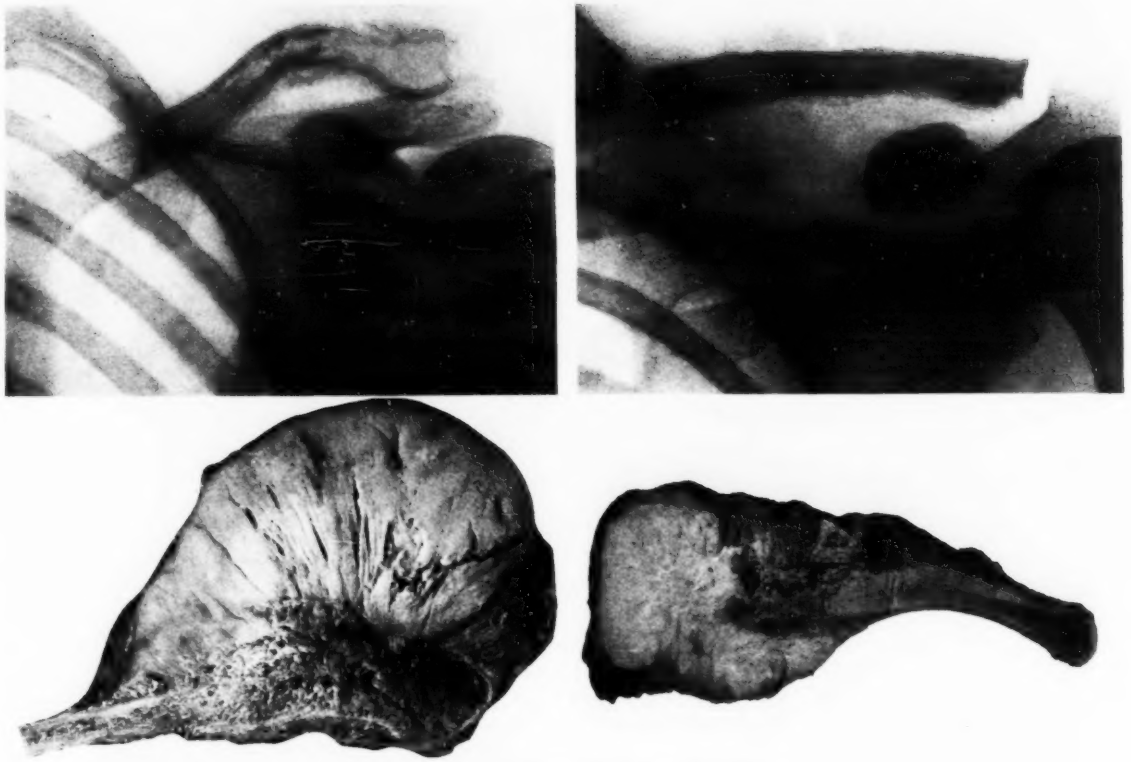


Plate 29. Cases 162 and 504. Roentgenogram and photograph of each specimen:
Lower left, osteogenic sarcoma in a girl 11 years old; 4 months after the onset. Death 11 months after the onset.
Lower right, Ewing's sarcoma in a woman 23 years old; 3 months after the onset. Death 8 months after the onset.
Showing the difference between osteogenic sarcoma and Ewing's sarcoma. In Ewing's sarcoma a destructive roughening of the periosteum is seen; the shaft of the bone is widened, while in osteogenic sarcoma the shaft with a preserved outline is passing through the tumor mass. In the photograph, Ewing's sarcoma shows a bulky fleshy soft tumor mass, while in osteogenic sarcoma the tumor mass is supported by a skeleton of radiating spicules. The periosteal spindle is well illustrated in osteogenic sarcoma.

in only two the ends of the bone were the seat of the tumor. The involvement is wide; commonly about half of the length of the bone is involved. Unlike osteogenic sarcoma which in the roentgenogram shows the shaft passing through the tumor mass grossly intact, Ewing's sarcoma shows the bone being slowly displaced by the tumor tissue (Fig. 66). The smooth absorption of the bone is accompanied by a widening of the shaft with frayed longitudinal bone trabeculæ. A destructive roughening of the periosteum is observed but there is no periosteal spindle and no lipping of the periosteum (Plate 29). The new bone is laid down parallel to the shaft; only in 3 cases out of 40 a radiating arrangement of new bone was observed (Figs. 67 and 68). In macerated and dried specimens small radiating spicules may be occasionally seen while in the roentgenogram they could not be perceived. The metastases in bone, which are typical of Ewing's sarcoma, have an appearance similar to the primary growth in the roentgenogram. A differentiation between Ewing's sarcoma and metastatic growths will be easily made if one remembers that metastases occur in the very young or after the age of 40, while most Ewing's sarcomata are seen in early adolescence.

In Ewing's sarcoma the pathological examination of tissue removed at biopsies is less reliable than in osteogenic sarcoma. If, in osteogenic sarcoma, tissue obtained through biopsies is not representative enough to allow a correct diagnosis, even more is this the case with Ewing's sarcoma. Also the fallacies of technical procedure are such that one rarely encounters a well prepared histological section which would warrant a diagnosis for the pathologist non-expert in bone tumors. There are numerous examples of the pathologist supporting the erroneous diagnosis made clinically and roentgenologically of osteomyelitis in the presence of Ewing's sarcoma. On the other hand it is fully attested at present that no other skeletal lesion so rapidly responds to radiation as Ewing's sarcoma. The suppression of Ewing's sarcoma by radiation is so marked that it in itself presents a most valuable diagnostic point in this disease. Viewed largely, the diagnostic limitations of pathology combined with the dangers of exploratory incision in Ewing's sarcoma require that a therapeutic radiation test should be substituted for exploratory incisions in cases suspected of Ewing's sarcoma (Plate 30). The intermittent symptoms, the characteristic roentgenogram, the therapeutic result will lead to a correct diagnosis.

Therapy and Prognosis

The general points of the therapy of bone sarcoma as pointed out in the chapter on osteogenic sarcoma are partly applicable also to Ewing's sarcoma. The general rapid response to radiation of Ewing's sarcoma is the main difference between this tumor and osteogenic sarcoma. Heavy radium and roentgen-ray radiation suppresses Ewing's sarcoma and causes a regression of the tumor in a short time (Plates 31 and 32). Unfortunately the enthusiasm from the first

Fig. 67. Case 541. Ewing's sarcoma in a boy of 12 years. The roentgenogram was taken 1 month after the onset of the disease. The widening of the shaft with the parallel striations is typical of Ewing's sarcoma.

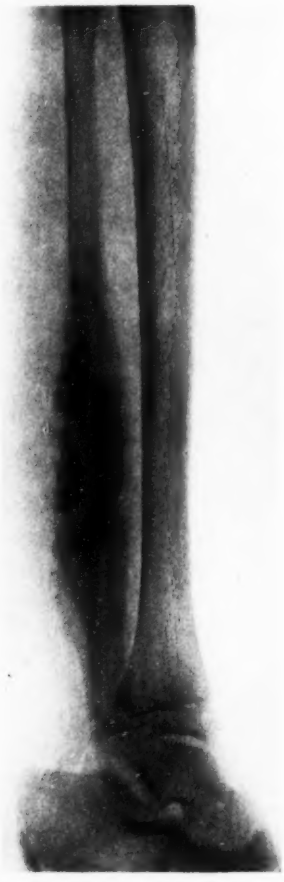


Fig. 68. Case 418. Same case as that in Plate 25. Ewing's sarcoma in a boy 10 years old. Notice the radiating spicules of the new bone in the presence of all features of Ewing's sarcoma in the roentgenogram.

impression lost ground later when experience showed that the tumor, being very susceptible to physical therapy, tends to recur and slowly become refractory to further radiation. There are, however, at present on record cases of Ewing's sarcoma remaining well up to four years after the onset, in which radiation alone was used. In the material of the Registry the patients with Ewing's sarcoma lived longer who had operative treatment accompanied by radiation.

Plate 30. Case 538. The same case as that in Figure 65. Ewing's sarcoma. Showing the response to radiation therapy. Roentgenograms taken 16 months after the onset, (left) and after several exposures to roentgen rays. By a trial of radiation at a much earlier date one would have avoided in this case repeated exploratory operations.

Plate 31. Case 173. Same case as that in Figure 59. Ewing's sarcoma in a boy 16 years old. Roentgenogram taken 8 months after the onset; the leg was amputated 4 years after the onset. In the interim radium was used. Showing the temporary suppression of growth of the tumor by radiation; the gross outline of the cortex is almost completely restored.

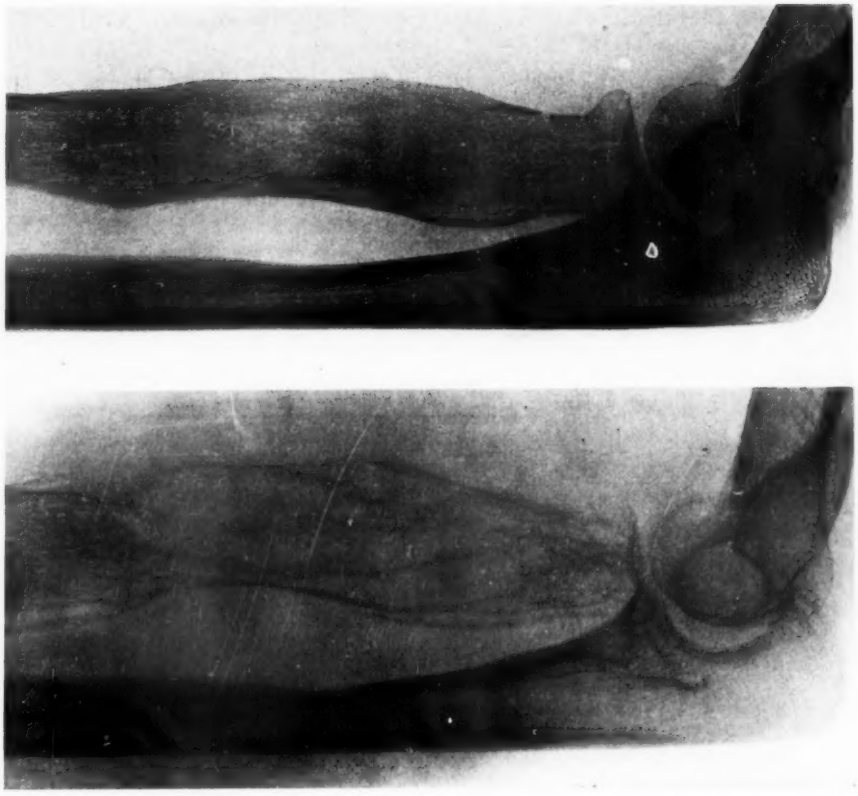


Plate 32. Case 352. Ewing's sarcoma in a girl 14 years old. An exploration was made about 1 year after the onset, at which time radium packs were applied with a good immediate local result. Death with skull metastases 3 years and 2 months after the onset.

Yet since radical surgery does not seem to prevent multiple tumors in the skeleton, amputation is possibly futile. The best way probably to deal with a Ewing's sarcoma is first immobilization of the affected region and heavy radiation; when the tumor recurs locally, then excision or even amputation can be performed. Radiation is to be continued for a longer period of time than is usually done in osteogenic sarcoma. Cases are known of the spontaneous disappearance of roentgenological evidence of pulmonary metastases for a period of years after heavy radiation. Overradiation is to be feared, since it prevents further radiation because of skin burns and because it is apt to destroy the bone produced as a result of the previous radiation. The dosage of radiation required is a matter of experience. The general impression is that radium is to be preferred to roentgen ray in Ewing's sarcoma.

As with all malignant bone tumors, prognosis as to life expectancy in Ewing's sarcoma is not possible for reasons which were pointed out elsewhere. In Ewing's sarcoma the treatment especially intimately influences the prognosis. If an average prognosis of cases with a diverse clinical course, seen in different stages of development and treated by varying methods is of any importance, then the average duration of life in Ewing's sarcoma is longer than in osteogenic sarcoma—in Ewing's sarcoma about three years while in osteogenic sarcoma about twenty months. The wide range of life duration is evidenced by the fact that one patient of the Registry cases is alive sixteen years after the onset of the disease while several patients died 5 months after the onset of the tumor.

As a disease favoring the young and adolescent Ewing's sarcoma does not show any appreciable difference in prognosis in relation to the age of the patient. There is also no evidence as yet to lead to the presumption that histological varieties of Ewing's sarcoma have anything to do with the prognosis, and the attempts made (Connor) to segregate certain varieties of these tumors probably lack clinical justification. Because of the longer life duration in Ewing's sarcoma there is greater possibility of influencing the tumor by radiation and occasional surgery, and a longer period of time in which to do it.

MYELOMA

PATHOLOGY—*Gross Anatomy*

THE voluminous and detailed descriptions in the literature of this disease are frequently based upon questionable material. As a matter of fact, myeloma is a rare condition, experienced pathologists having seen but few cases in years. Not infrequently a tumor is diagnosed as myeloma simply because of the round shape of the cells composing it. That Ewing's sarcoma is sometimes confused with and taken for myeloma I have repeatedly observed. These facts partially explain the reasons why the pathology and also the clinical course of myeloma is often being presented in different, frequently contradicting descriptions. Probably this will continue to exist until we learn more of the normal anatomy of the hæmatopoietic system in general. The numerous names offered by various investigators for the disease known today as myeloma attest the great confusion existing as to the true nature of the condition. Although myelomata are rare, they are of sufficiently frequent occurrence to warrant a consideration of this tumor in a study of primary malignant bone tumors.

In divergence with osteogenic sarcoma myelomata favor the midportions of the long bones, especially the humerus and the femur and the flat bones of the skeleton such as the sternum, ribs, skull, and the vertebræ. The tumor forms nodules ranging in size between that of a bean and that of an orange. It readily spreads along the marrow cavity, replacing the normal bone-marrow so that only on the edges of the expanding growth can one see tumor cells intermingling with normal bone-marrow elements. The tumor steadily expands in the transverse diameter of the bone. The destruction of the bone is less diffuse, is of more rapid course, and of more circumscribed character than that seen in Ewing's sarcoma. Usually no osteoclasts are assisting the tumor cells in the destruction of the bone. The cancellous bone rapidly melts down at the approach of the tumor cells. The cortical bone becomes eroded and the tumor protrudes beneath the periosteum, which is slowly undermined and pushed away from the doomed cortex. Repeatedly the periosteum forms new layers of bone in place of the thinned out or completely destroyed cortex. This new bone shell, however, rapidly melts down under the aggression of the tumor cells. As a result of this periosteal reaction the bone cortex seems expanded and the medullary cavity widened. Finally the periosteum becomes perforated here and there and the

Plate 33. Case 461. Myeloma. The medullary cavity is stuffed with tumor; pathological fracture; hæmorrhage and blood cysts.

tumor infiltrates the surrounding structures. Bending and deformity of the involved weight bearing bone may take place and spontaneous infraction or complete fracture may follow. The gross specimen usually shows a greatly thinned cortex of an expanded bone filled with an increased medullary substance, soft or firm, translucent or opaque with little or no bone trabeculæ in it. The tumor mass is gray, reddish gray, or deep red according to the vascularity. The

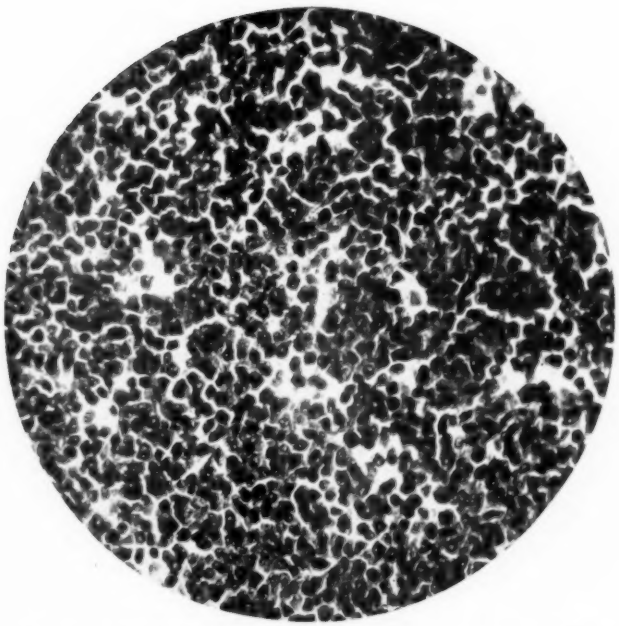


Fig. 69. Case 242. Compare with Figure 70. Myeloma, plasmocytoma. Low magnification.

vascularity is sometimes so great as to cause pulsation of the tumor. Hæmorrhage from the very thin walled capillaries is frequent; hence blood cysts and pigmentation. Extensive regressive changes are frequent with the usual changes in the cells (Plate 33).

Structure

The histogenesis of myeloma is still a field of much theorizing and speculation. Taking myelocytes, lymphocytes, and mononucleated red blood cells as the specific bone marrow cells, tumors have been described which were said to originate from each of these basic specific cellular elements. The majority of myelomata are composed of nongranulated mononuclear cells with opaque basophilic protoplasm, closely resembling the plasma cells, with which they are frequently identified. In other words the most frequent myelomata seem to be constituted by cells the origin of which is still being debated. In connection with this, it may be mentioned that an idea that all types of myeloma are composed of cells merely representing various stages of anaplasia in a single cell is being entertained. Ewing thinks that the fact that the myelocytoma is of more active growth than the plasmo cytoma, suggests that a greater degree of anaplasia may

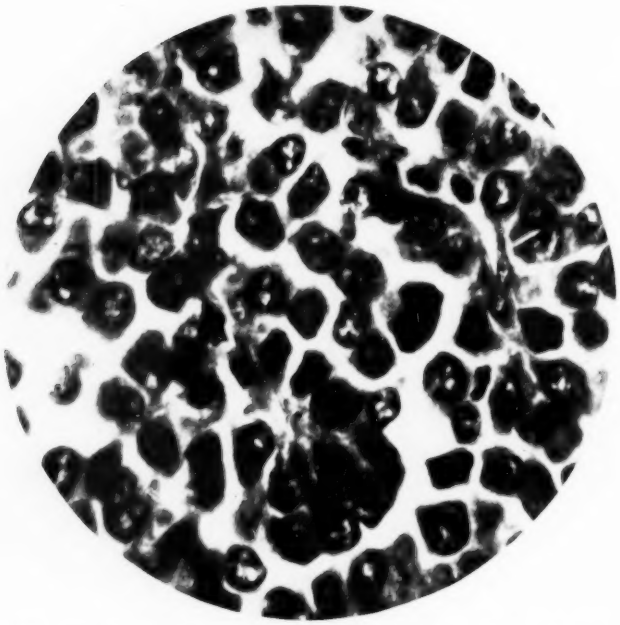


Fig. 70. Case 242. Compare with Figure 69. Plasmocytoma. High magnification.

lead a plasma cell to become a cell resembling a myelocyte. The general trend of opinion favors the origin of the plasma cell from the lymphocyte or from endothelium. According to some authors, the ability of the plasma cell myeloma to destroy bone speaks in favor of this latter alternative. Whatever the histogenesis of myeloma may be, four various types of myeloma are classified by various authors each with a different type cell and possibly with a slightly different clinical course. In order of frequency of occurrence these types are plasmocytoma, lymphocytoma, myelocytoma, and erythroblastoma. The type cell in each of these types is easily recognized in sections, but the rapidity of growth and frequent degenerative changes may obscure the appearance sufficiently to make it extremely difficult to differentiate exactly the type cell of the tumor. Among the plasmocytomata one encounters a small and large cell variety; the latter are said to be of more rapid growth and somewhat worse prognosis. The cells are usually round and oval but from pressure may become polygonal and even spindle formed (Figs. 69, 70). The nuclei are small and eccentric with granules of chromatin arranged along the nucleolar membrane. Not uncommonly the cells are multinucleated. The tumor cells are loosely packed, without any intercellular substance, without any definite arrangement and with

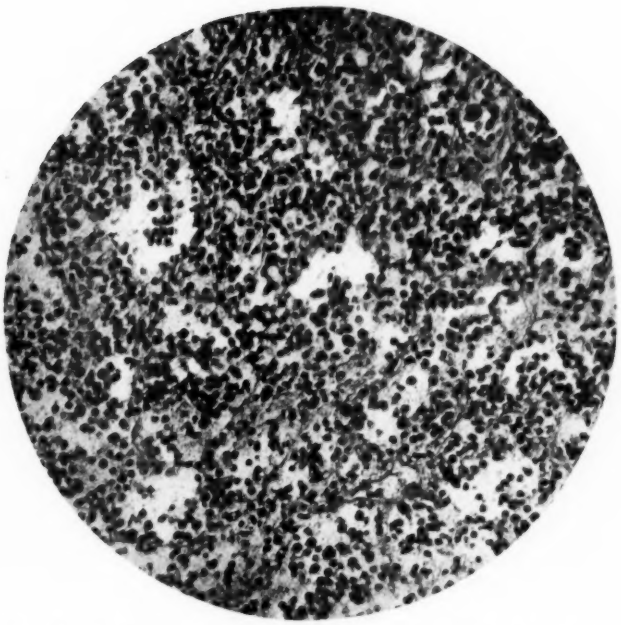


Fig. 71. Case 517. Myeloma, myelocytoma; a capillary web variety.

a scanty stroma supporting them. The lymphocytoma is less aggressive. It is composed of typical small lymphocytes. The type cell in myelocytoma resembles a myelocyte (Fig. 71). The large hyperchromatic cell with prominent granules readily suggests the myelomatous nature of the tumor. The erythroblastoma is called so because the two cases described in the literature showed hæmoglobin in the tumor cells. Hæmoglobin was so abundant that it caused a deeply brownish red color of the tumor. The Registry material is poor in myeloma, the 9 typical and 5 questionable cases registered belonging to neither of the two last mentioned types. For common use among clinicians and pathologists a subdivision of myeloma into types is probably of no advantage. Distinction of finer points in the histology of myeloma is at present of purely scientific interest.

Clinical Course

Unlike osteogenic sarcoma and Ewing's sarcoma neither the history nor the physical examination of a patient with myeloma in the early stage is in any way characteristic of the disease. This fact combined with the rare incidence of myeloma largely explains the fact that myeloma is seldom recognized before very extensive involvement takes place. The disease chiefly affects males mostly

Fig. 72. Courtesy of Dr. Holmes, Massachusetts General Hospital; not registered. Myeloma in a woman 56 years old. The same case as that in Figure 73.

between the ages of 40 and 60. Myeloma in the advanced stages extends throughout most of the bone, not infrequently replacing the entire bone marrow. For a long time it was considered a multiple lesion, originating and developing in multiple foci. Only one case of solitary myeloma was recorded.

Despite the multiplicity of myeloma in most cases the disease is connected with a traumatic history. As in other malignant bone tumors, pain is an important factor in the clinical course of myeloma, although it seems to appear considerably later than in most osteogenic sarcomata. In myeloma of the spine, cord pressure is a frequent finding. The general condition of the patient depends upon the stage of the disease; in far advanced stages a peculiar cachexia and emaciation is seen. A secondary anæmia as a result of a marked destruction of the bone marrow accompanies the cachexia. In early stages the blood may not show any changes. Cases have been described of an increase of myelocytes or plasma cells in the blood. The incipient fever is later displaced by a subnormal temperature. Palpation may sometimes reveal crepitation of the extremely thin cortex, an enlarged spleen and possibly a hyperplasia of the regional lymph nodes. The enlargement of the spleen is possibly compensatory to the destruction of the bone marrow or in the advanced stages is perhaps due to toxæmia.

Because of the rapidity of bone destruction, a pathological fracture, a bone deformity or a crushing of a vertebral body with a paraplegia is frequently the first sign of the bone lesion. Generalization of the disease through metastasizing to other organs is a feature of the natural life of a myeloma. However, frequently cases come to postmortem examination without metastases to soft organs. This is probably because the patients die early from the severe emaciation and intoxication as a result of extensive bone-marrow destruction.

Fig. 73. Same case as shown in Figure 72. Myeloma in a woman 56 years old.

Secondary growths have been seen in the liver, spleen, kidneys, regional lymph nodes, and skin.

Diagnosis

The radiological method is the main one in the diagnosing of myeloma. The history and clinical picture of an early stage of the disease is not remarkable as far as diagnostic possibilities are concerned except in regard to multiplicity and situation. In a far advanced case the multiplicity of involvement suggests multiple myeloma rather than Ewing's sarcoma. The absence of pulmonary metastases in the presence of very extensive skeletal involvement is the rule in myeloma. The age of the patient is also suggestive of myeloma; they occur after 40 years of age. Albumosuria and the presence of Bence-Jones proteins in the urine which for a long time has been considered pathognomonic for myeloma, may be absent in a large percentage of cases—according to some observers in one half. On the other hand in occasional carcinomatous skeletal metastases and other medullary tumors the presence of Bence-Jones proteins has been observed.

For obvious reasons morphological blood studies, which, as a routine, should be made in all skeletal tumors, should never be omitted in myeloma. In the roentgenogram myeloma reveals well outlined, definitely circumscribed areas of diminished density. At one stage or other these areas may be large and single or small and multiple in the same bone spreading all along the medullary cavity. The bone is slightly expanded by the individual nodules so that the extremely thinned cortex is irregularly wavy in outline and not uniform in thickness (Figs. 72, 73). There may be minute nodules in the cortex itself. A perforation of the cortex is rare and so is an infiltration of the soft tissues about the involved bone. The very characteristic roentgenogram may be greatly obscured by frequent infractions or complete pathological fractures, which may present diagnostic difficulties. When myeloma is located in the spine it is difficult to identify the individual myelomatous nodules because of the greatly atrophied bone structure. Partial collapse of a vertebra and apparent disappearance of intervertebral discs is not an infrequent occurrence in myeloma of the spine. A radiological examination of the whole skeleton is extremely important.

In making a diagnosis from a histological section one has to keep in mind that an overstaining with hæmatoxylin may lead to mistaking Ewing's sarcoma for myeloma. Myeloma generally shows mild pleomorphism as compared to Ewing's sarcoma. An exploratory incision is both undesirable and unnecessary because of the promptness with which myeloma responds to radiation. The diagnosis is early established from the very characteristic roentgenogram.

Therapy and Prognosis

As a tumor composed of lymphoid cellular elements, myeloma is readily affected by radium and high voltage roentgen rays. The local growths disappear after repeated radiation, and pathological fractures may unite under such treatment, but ultimately death follows from extension and metastases. When the disease appears with multiple tumors there obviously can be no choice between surgical treatment and radiation, the latter being the sole recourse. In the rare instances of solitary myeloma, amputation may be justified and according to some observers it may for long postpone or even prevent metastases. However, the frequent location of myeloma in the spine and the sternum will decide against surgical treatment even in cases of solitary tumors. The histological variations of the tumor do not influence the effect from radiation. It is questionable, however, whether continuation of radiation is permissible when the leucopenia reaches 2,500. To prevent a pathological fracture, immobilization of the involved limb and recumbency is essential. On the whole myeloma may prove occasionally of decidedly better prognosis than other malignant bone tumors. Cases are on record in which ten and more years have passed between the clinical onset and the fatal termination of the disease.

UNCLASSIFIED SARCOMA

IN the group of "unclassified sarcoma" are included, aside from a few atypical instances, two conditions which are endowed with a typical anatomical structure and characteristic clinical behavior. The exceptional rarity of these conditions has prompted me to refrain from a segregation of them under separate headings in the classification. These tumors are angio-endothelioma and extraperiosteal sarcoma of bone.

ANGIO-ENDOTHELIOMA

Pathology

OUR knowledge of osteogenic sarcoma, Ewing's sarcoma, and giant cell tumor has gained tremendously from the Registry, but the latter has contributed little to the knowledge of angio-endothelioma. The pathology of angio-endothelioma of bone is still a very confused problem. The reasons are numerous. Since the days when Golgi, over fifty years ago, first offered the name "endothelioma" this term has been applied extensively to uncommon tumors both of soft tissues and of the skeleton. The at first sight histological resemblance of endothelioma to carcinoma has led to the diagnosis of endothelioma in cases of secondary carcinoma in which one failed to find the primary tumor. This error has been followed in our days by the tendency of pathologists to dodge the diagnosis of endothelioma and to substitute for it carcinoma even in cases in which much of the histological and clinical evidence is in favor of the former diagnosis. Further confusion was brought in by the fact that in the literature the rare primary angio-endothelioma of bone is confounded with an occasional secondary involvement of the bone by an endothelioma of the adjoining soft tissues. Such lesions are especially frequent in the skull where the endothelium lined dura represents the endosteum of the bones of the skull. The local changes in the skull overlying a dural endothelioma or meningioma, as Cushing calls this tumor, lead to the formation of a dome shaped bony prominence, which on section shows hyperostosis infiltrated by tumor elements from the underlying primary tumor of the dura. Often these changes in the skull have been mistaken for sarcoma, and in such cases the primary lesion, the tumor of the dura, was overlooked. It is easy to see how such an error can be made when it is realized

Fig. 74. Case 154. Same case as that in Figure 75. Skeletal angio-endothelioma. The tumor cells form alveoli and tubuli.

that the fan-like radiation structure of the hyperostosis in the roentgenogram is reminiscent of the structure frequently seen in osteogenic sarcoma. It is hardly necessary to point out here the dangers, on one hand, of mistaking a secondary tumor of the bone for a primary and, on the other hand, of confusing different types of tumor which have nothing in common clinically or anatomically. It is fully ascertained that endothelioma of the dura does not metastasize and is not even locally malignant as far as infiltration of the brain is concerned.

Another source of error arose in connection with the facts that microscopically one of the leading features of angio-endothelioma is the abundant vascularity; a confusion of angio-endothelioma with angioma and angiosarcoma is probably best explained by this fact. However this may be, this still further contributed to the confusion existing about angio-endothelioma of bone. Various interpretations by individual investigators of histological findings even in true angio-endothelioma of bone did not help much to clear this problem. Such a discrepancy of views and opinions is only natural when one realizes that the tumor is exceedingly rare, the men with most experience having seen only a few cases.

The knowledge of the embryological relations of the cells called endothelium is yet far from complete. However, it is fully attested that the endothelium is

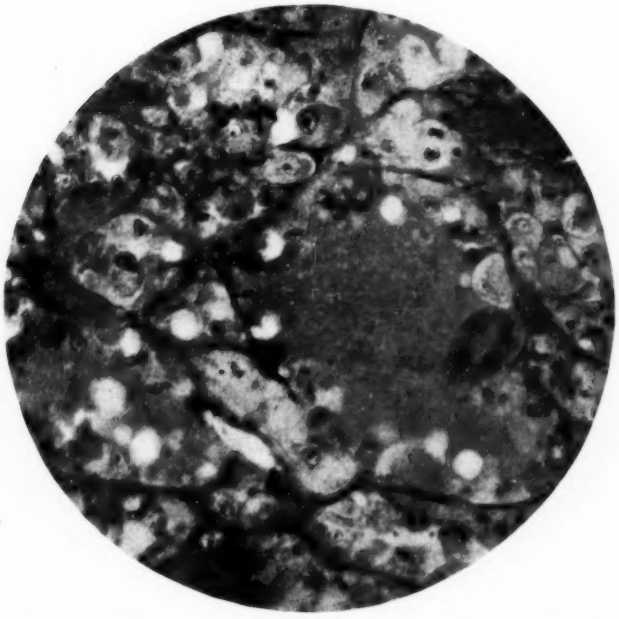


Fig. 75. Case 154. Same case as that in Figure 74. Skeletal angio-endothelioma. Alveoli with intact blood are lined by a single row of tumor cells simulating vascular endothelium.

derived from mesenchymal cells; it has differentiated along various lines because of its function—walling of vascular channels and spaces. As has been mentioned, angio-endothelioma of bone is a very rare tumor, the Registry having, in my opinion, only two cases. These two cases have been used by me in a special study with the intention of urging recognition of angio-endothelioma of bone as a definite anatomical entity.[1] It is obvious that no very extensive and definite conclusions as to their histology can and should be attempted,—it is not safe theoretically and it is of no importance from the clinical point of view. There is no sufficient evidence to support a distinction between hæm- and lymph-angio-endothelioma at least as far as bone is concerned; the numerous pitfalls surrounding such detailed studies in bone may lead to a confusion in which our meagre knowledge of angio-endothelioma of bone would be stripped of the facts at present fully attested.

In general features the most frequent histology of skeletal angio-endothelioma will at first glance impress one with the resemblance to an adenomatous growth.

[1]Kolodny, Anatole. A case of primary multiple endothelioma of bone. Arch. Surg., 1924, ix, 636. Idem. Angio-endothelioma of bone. Arch. Surg., 1926, xii, 854.

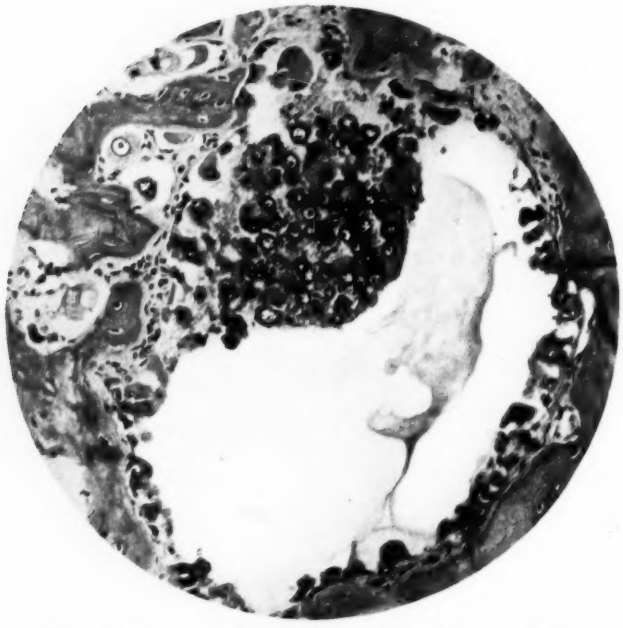


Fig. 76. Case 291. Skeletal angio-endothelioma. Showing proliferation and piling up of blood vessel endothelium.

The tumor cells are arranged in alveoli and tubules. The interalveolar septa form the base upon which the tumor cells are lined (Fig. 74). The cells may vary with the maturity of the tumor. In the young areas the alveoli are small, filled with tumor cells, without any perceptible lumina. The tumor cells are large polyhedral sometimes cylindrical with a well defined cell membrane and with pale vesicular nuclei and minute nucleoli. At a later stage the alveoli show lumina, sometimes filled with circulating blood. At a still later stage the tumor cells are undergoing degenerative changes. The most interesting feature is the frequent lining of alveoli with intact blood by a single row of tumor cells well simulating vascular endothelium (Fig. 75). It is not uncommon to be able to trace the origin of the tumor cells to normal appearing blood vessel endothelium (Fig. 76). In some cases the tumor cells do not enclose intact blood but form small alveoli or small cysts containing mucinous material. The cells may be more cylindrical and quite resemble carcinoma. A common feature is the fact that the strands of tumor are intimately connected with the supporting stroma and the surrounding tissue and are not separated from it by means of endothelial cells lining the connective tissue spaces, as is always seen in carcinomatous metastases. Well differentiated and low grade new formed bone may be seen

throughout the tumor. The question of the relation of the supporting stroma to the tumor elements is disputable; there is strong evidence on hand, however, that endothelioma may give rise to intercellular substance and fibrils as was described by Lubarsch and Marchand with reference to serous endothelioma.

There is described in the literature another type of endothelioma, a so-called intravascular variety which to my knowledge is not represented in the Registry material at all. This variety, usually multiple, consists of diffuse cords and sheets of clear polyhedral cells often surrounding capillaries with circulating blood. The possibility of the relationship of these tumors to myeloma is inadequately recognized, and the possibility is greater since these tumors have a myelogenous origin and not an endothelial one.

Clinical Course

Clinically angio-endothelioma of bone so much resembles osteogenic sarcoma that it is commonly submerged under the diagnosis of "bone sarcoma." The tumor is too rare a condition to allow definite conclusions as to the clinical incidence, age, and site of predilection. The fact that only two cases were recognized by me in the Registry material suggests that the clinical incidence is extremely low. The tumors may be encountered in old as well as in young. They seem to be prone to occur in any bone of the skeleton, especially in the long bones. Subjectively the clinical symptoms and signs are in general the same as those in osteogenic sarcoma, save perhaps for a later date of appearance of pain. The tumors may grow to a large size. In one of the cases (No. 154) the tumor led to absorption and destruction of bone while in the other (No. 291) a definite inclination to bone production was evident. In the first case no bone capsule was present and the periosteum was found free of any osseous tissue while in the second bulky osteoblastic tumors were produced. It is thought that angio-endotheliomata have a tendency to remain long enclosed in their investing capsule. Apparently the tumors may be single and multiple, while it is impossible to determine whether or not the multiple tumors are metastases of one primary tumor. The tumors may produce metastases through the blood and lymph stream, ending fatally from pulmonary metastases. While the clinical course is slightly slower than that of an average osteogenic sarcoma, the outcome is the same.

Diagnosis

The rarity of angio-endothelioma of bone and the scarcity of material available for study make obvious the peculiar diagnostic difficulties of this tumor. Unlike other malignant bone tumors the history and clinical appearance of angio-endothelioma is of no diagnostic significance. For the same reasons little can be expected from the radiological examination. Indeed, there are no points of diagnostic value because of the diversity of features of this tumor, the tumor

occurs in young and old, solitary and multiple, destructure—with apparent complete washing out of the bone shadow in the roentgenogram—and productive—with formation of large bulky bony growths. The diagnosis rests upon the histological structure of the tumor. But here also numerous pitfalls make a correct diagnosis difficult. The salient features of the histological structure of angio-endothelioma have been pointed out above. There are, however, certain points which are of especial importance in diagnosing the tumor. One of the main features which cannot be overemphasized is the fact that the presence of blood between acinous clusters of tumor cells is not to be considered as evidence that the cells formed a vascular space during the life of the tumor. Neither does the so-called perithelial arrangement of tumor cells mean that the tumor is an angio-endothelioma. The lack of realization of this fact has led to the erroneous diagnosis of these tumors as angio-endothelioma in numerous instances.

Another important and frequent source of error arises from too large expectations of a study of morphology of the tumor cell. There are no absolute signs of an endothelial cell, and one can never be certain from the morphological appearance that a given cell is really endothelial. From this fact, one infers that unless the origin of the tumor cells can be traced to vascular endothelium, the diagnosis of angio-endothelioma is not to be considered unquestionable.

In every case of suspected angio-endothelioma the possibility of a metastatic origin must be considered and eliminated. It is imperative to remember that a hasty pathological examination may lead to an erroneous diagnosis. In the literature cases of angioma and endothelioma of soft parts with secondary involvement of the adjoining bone were often confounded with angio-endothelioma.

Since angio-endothelioma does not respond in a noticeable degree to radiation, a therapeutic radiation test is probably of no promise. An exploratory incision is of doubtful advisability in these tumors; while such incisions are subject to all hazards of cutting into a malignant tumor the diagnostic advantages of exploration promise little here since no method is known to influence the course of the tumor or to prevent metastases after radical surgery.

Therapy and Prognosis

The question of the therapy in angio-endothelioma as it stands today is wide open. We have not the slightest conception about influencing the growth and fatal course of this tumor. The few cases observed do not allow any valuable conclusions as to the therapy. The limited experience gained, however, does show that there are no surgical cures and no improvement from radiation, roentgen ray, or radium; this despite the vascular structure of the tumor. Early metastases and multiple origin of these tumors still more aggravate the prognosis of this disease. Purely symptomatic relief is the only help that can be offered patients afflicted with this disease.

EXTRAPERIOSTEAL SARCOMA

Pathology

As was pointed out in the chapter on classification, by the term extraperiosteal sarcoma is understood a tumor which is intimately related to the periosteum but is entirely extracortical, not invading or infiltrating the bone. This tumor arises from the fibrous layer of the periosteum and not from the bone producing cambial layer. Thus, this tumor arises from nonspecific fibrous tissue which is incapable of producing osseous tissue. This difference between this tumor and osteogenic sarcoma substantiates the pathology, gross and microscopic, the radiological features, and the clinical course. Since this tumor originates from or is attached to the fibrous layer of the periosteum its investing capsule is not formed by the periosteum as is the case in osteogenic sarcoma. These tumors remain encapsulated for a long time and in their growth they push aside the soft tissues rarely infiltrating them.

While as a rule these tumors do not invade the bone, they may, however, cause absorption or slight erosion of the bone as a result of pressure, or they may push aside the adjacent bone and cause deformities. In cut section the tumor is firm, fibrous, white, glistening, with easily distinguishable fasciculi; occasionally it is cellular, soft, and crumbly, when regressive changes are extensive. In such tumors we see necrotic areas with formation of cysts filled with a dark brown fluid, probably a result of necrosis with extravasation. Histologically these tumors do not show any relationship to bone and this relationship is to be judged from the gross anatomy. The leading histological picture of this tumor is that of a fibrosarcoma. Its various sized cellular elements are of the spindle cell type. These cells resemble fusiform fibroblasts and when loosely arranged their granular cytoplasm can be easily seen. When compactly grouped, these cells show no cell borders, the nuclei seemingly occupying the whole field. Elongated processes of the cytoplasm form a distinct intercellular substance consisting of abundant fibrils. With the increase in size, the tumor cells may be pleomorphic. By special methods of staining one can readily bring out a fibrillar intercellular substance loosely arranged between borders of spindle cells. In rapidly growing tumors one sees abundant capillaries consisting of single rows of endothelial cells; on a superficial examination it appears that blood courses in lumina composed by tumor cells without any help of endothelial cells.

Clinical Course

The very few reported cases in the literature and the very limited number of tumors resembling extraperiosteal sarcoma on record in the Registry seem to indicate that the clinical incidence of this disease is very low. The difficulty of distinguishing with certainty these tumors histologically from fascial sarcoma and the ease with which the relationship of these tumors to the periosteum may remain unrecognized at operation probably cause a misrepresentation of the clinical incidence. In their onset, course, and physical findings these tumors hardly differ from fascial sarcoma. The relationship of the tumor to the bone, a broad attachment to the periosteum, may not be judged from the pre-operative findings on palpation; large tumors may be freely movable despite their attachment to the periosteum of the bone. There does not seem to be any definite relationship between the incidence of the tumor and age; I have observed one case of extraperiosteal sarcoma of the tibia in a newborn child, at present alive and well, 10 years after amputation of the thigh.

Diagnosis

With the difficulty of distinguishing an extraperiosteal sarcoma from a fascial sarcoma even at operation it is evident that the pre-operative diagnosis must be largely provisional. The roentgenogram, however, may give some points suggesting the diagnosis. Usually the roentgenogram shows an intact or slightly eroded shaft of the bone running through a tumor mass which is poorly outlined because of the faint shadow that it casts. The tumor does not surround the bone circularly. Since the periosteum does not actively react to the presence of the tumor one does not see here the periosteal spindle or lipping so frequently manifested in osteogenic sarcoma. Since the tumor does not invade the bone but may cause pressure deformity one may encounter roentgenologically changes in the contour of the bone. Occasionally the tumor may lead to proliferative processes of the bone to which it is attached; the outline of the bone then remains smooth as in benign osteogenic tumors. Sometimes the tumor causes superficial erosion of the bone. In such tumors of fingers or toes one is reminded of gout when the bone is eroded, but instead of being rarefied, atrophic, it is denser than normal. A gout tuft can be easily recognized grossly from the gritting of the uric acid crystals when cut with a knife (Plate 8).

Therapy and Prognosis

Radical surgical removal is the operation of choice in extraperiosteal sarcoma. Thorough incision may be followed by permanent recovery. A considerable number of cases reported in the literature as cures of "bone sarcoma" after surgical operations probably belong to the extraperiosteal sarcomata. The

prognosis is especially favorable when the tumor is found encapsulated. After incomplete excision these tumors may recur but with a moderate tendency to produce metastases. Recurrence is not unusual in the large, more actively growing tumors in which regressive changes are frequent. With the recurrence, the texture of the tumor may become more anaplastic and malignant. Not uncommonly the intimate relationship of the tumor to the periosteum is overlooked at operation, the extraperiosteal sarcoma is mistaken for a fascial sarcoma and the attachment to the periosteum is left behind. Surgical removal of a fibrous sarcoma located close to a bone therefore should be followed by prophylactic radiation therapy, preferably with roentgen rays.

GIANT CELL TUMOR

Pathological Concept and Etiology

THE clinical and pathological aspects of giant cell tumor of the skeleton are so at variance with the malignant skeletal tumors that a discussion of the disease here calls for explanation. As is inferred by the name, by giant cell sarcomata are understood lesions the histological structure of which is characterized by an abundance of giant cells. However, such a definition of giant cell sarcomata would be erroneous since not all tumors showing the presence of giant cells belong here. Three types of giant cells can be distinguished in pathological conditions. First come the giant cells which are a result of karyorrhexis in the cellular elements of the tumor. This is especially frequently observed in rapidly growing malignant tumors where the division of the cytoplasm cannot keep pace with the closely following, repeated divisions of the nucleus. The nuclei here are of various sizes and shapes, frequently not completely separated from each other. These giant cells are a significant part of the parenchyma of the tumor. Following the lead of Mallory these are spoken of as true tumor giant cells. Another type is the so-called foreign body giant cell. These occur in tuberculosis and in gummata; they are the Langhans type of giant cells with a peripheric or bipolar arrangement of their nuclei. The third type is represented by the giant cells of the so-called giant cell sarcoma which is here designated as giant cell tumor. The nuclei are uniformly distributed throughout the central portion of the cell; they are of equal size and completely separated from one another. The fact is still insufficiently realized that only lesions with giant cells of the third type are understood under the term of giant cell tumors. Skeletal lesions designated as giant cell sarcomata are of three varieties: (a) the giant cells containing new growths observed in the course of osteitis fibrosa, (b) the epulis, and (c) the giant cell tumor. The lesions marked under (a) are generally conceded to be of purely inflammatory character and obviously do not belong in the present analysis. Epulis, as the term infers, is a lesion of the gums or alveolar periodontium rather than of the bone itself. The benign course of epulis has been generally realized for a long time and to include epulis in our present study of giant cell tumors could be justified merely for reasons of emphasis, for such an association would tend to stress the point of benignity of giant cell tumors.

The term giant cell tumor is applied to a condition which has been and still is known in various countries and even in one and the same country by different

names. *Tumeur à myéloplaxes* given by Nélaton has changed to myeloid sarcoma and myeloma, which is still being used in the British literature; it is also known as giant cell sarcoma, benign giant cell sarcoma of the epulis type, giant cell sarcoid, osteitis fibrosa cystica, hæmorrhagic osteomyelitis, and giant cell tumor. The benign character of giant cell tumors is not yet generally recognized, and not infrequently the lesion is still looked on as a sarcoma. The fact that hundreds of cases of giant cell tumor have been sent to the Registry of Bone Sarcoma by clinicians and pathologists the country over is sufficient justification of the necessity of the discussion of this lesion in a monograph primarily dedicated to malignant bone tumors.

The question of the etiology of giant cell tumors is at first glance intricately interwoven with an academic question: Is giant cell tumor a neoplasm or a product of inflammation and repair? The acceptance of the name giant cell tumor as a substitute for all other names of this lesion is not to be looked upon as proof of the neoplastic nature of the lesion; the term "tumor" is used here merely in a clinical sense, that is, to indicate a swelling, inasmuch as the pathological anatomical sense of this word is at present not entirely clarified. The question of whether a giant cell tumor is a true blastoma or merely an inflammatory process follows an old trodden path of discussion; a similar question was in vogue twenty-five years ago in relation to the new growths observed in the course of osteitis fibrosa. It was Mikulicz who then in the light of contemporary knowledge warned against the wrong assumption that bone cysts are results of true tumors which have undergone softening and degeneration. As it stands today the concept of the disease known as giant cell tumor divides investigators in two opposing classes. To one belong those who look upon a giant cell tumor as a true blastoma and to the other those who see in it merely a product of inflammation and repair in bone. Since the view upon giant cell tumor as a true blastoma is supported by tradition, the burden of proof in this dispute lies on the promulgators of the inflammatory nature of giant cell tumors. The leaders among these are Mallory, Codman, and Barrie in this country and Lubarsch and Konjetzny in Europe. Mallory has long maintained that the giant cells of the giant cell tumor are not an integral part of the lesion but only a biological reaction of the large mononuclears of the blood, the so-called endothelial leucocytes, which are found wherever retrograde changes are going on. As a reaction to calcium salts absorption these endothelial leucocytes fuse and form the giant cells. Aside from these giant cells no cells occur in these lesions which are not met with in ordinary inflammatory processes. Of the same opinion is Codman who sees in the giant cell tumor a repair process following intra-osseous hæmorrhages due to rupture of nutrient vessels. In Codman's opinion the tendency of this disease to form large expansive tumors does not warrant considering it as a neoplasm any more than does the enlargement of an aneurysm.

Strongly substantiated by results of special investigations are the opinions of Lubarsch and Konjetzny. Years ago Lubarsch had pointed out with the clarity and logic usual for him that the new-growths observed in the course of osteitis fibrosa are of purely inflammatory nature. Later he joined Konjetzny in the latter's interpretation of results obtained from special studies of giant cell tumors. On the side of histological preparations Konjetzny showed how an intermedullary hæmorrhage calls forth a reactive proliferative process. The product of this proliferative process of the bone-marrow which can be compared to granulation tissue consists histologically of all the elements encountered in lesions known as giant cell tumor. The clinical course and the radiological findings are very closely related to those of giant cell tumors. In the course of the natural life of this granulation tissue there is a stage of differentiation when fibrous tissue, osteoid, and sometimes osseous tissue take the place of the hæmorrhage after it has subsided, the blood clot organized, and all the foreign elements removed. Thus Konjetzny concludes that the apparent tumor is merely a "chronic-resorptive process."

The opponents of the opinion that giant cell tumors are true blastomata emphasize the following points of the histology of giant cell tumors as supporting their views: the absence of pleomorphism of the cellular elements and of hyperchromatism of the nuclei and the absence of excess of mitoses; the differentiation of the cellular stroma into dense fibrous tissue poor in cells; the uniformity in the size, shape, and chromatin content of the giant cell nuclei; the relation of the giant cells to extravasations, indicating their rôle in resorption; and the constant presence of old blood pigment. All these features are not inconsistent with the probable inflammatory nature of these lesions. If one admits the correctness of the views of these authors with reference to certain skeletal lesions and especially to the new growths occasionally observed in the course of osteitis fibrosa one is, however, prompted to accept the contention that along with these lesions there probably are also true blastomata very similar to these clinically and histologically. It is generally conceded how difficult it is to distinguish histologically between a new-growth in osteitis fibrosa and entirely independent lesions considered as giant cell tumors. Of course this fact alone is sufficient evidence to raise doubt as to the right by which giant cell tumor is occupying its place in oncology. On the other hand there is no sufficient evidence accumulated to support the contention that in all cases of giant cell tumor the lesion is a process of inflammation and repair.

The etiology of the typical giant cell tumor is readily understood if one accepts the new-growths observed in the course of osteitis fibrosa cystica as giant cell tumors. The term "osteitis fibrosa" is being greatly misused of late. The average roentgenologist is usually inclined to call osteitis fibrosa most of the bone lesions which he is unable to diagnose and classify. This fact well illus-

trates the need of further study of this little understood pathological condition. The main complex of osteitis fibrosa is the disappearance of hæmatoblasts and fat cells from the bone-marrow with a subsequent overgrowth of the fibrous stroma and lymphoid elements. This is accompanied by a simultaneous resorption of bone and new formation of osteoid tissue, and this leads later in the course of years to fractures and deformities. Frequently, in the course of the disease one encounters formation of cysts. Hæmorrhage into the cysts may lead to an overgrowth of masses, resembling granulation tissue, which may enlarge and finally be recognized as giant cell tumors. The purely inflammatory nature of these lesions has been emphasized above. The frequent history of an antecedent mild trauma in giant cell tumor has led to the recognition of trauma as an important etiological factor. As in malignant bone tumors, much depends upon the individual concept of trauma. It has been shown that a hæmorrhage into the bone-marrow may lead to cyst formation as it is observed in the brain. Organization of the intramedullary hæmatoma with the appearance of the peculiar medullary granulation tissue and expansion of the bone will then form the giant cell tumor. Very slight traumatization is frequently sufficient for the appearance of medullary hæmatomata. While it is usually thought that fractures are not the cause but merely a complication of giant cell tumor and osteitis fibrosa, it is probable that fissure fractures or, better, infractions with the rupture of nutrient vessels may lead to the formation of a giant cell tumor. The frequent presence of old hæmorrhage histologically in a giant cell tumor and the almost exclusive location of giant cell tumor in the ends of the bone in the spongiosa seem to support this view. Wright and Ewing brought forth evidence of the origin of variants of giant cell tumor from absorption of aberrant islands of cartilage cells which are not unusual in patients suffering from rickets in childhood. This absorption may lead to a neoplastic proliferation of the released cells. All mentioned factors, however, fall short of a satisfactory explanation of the etiology of all varieties of giant cell tumors and cases are encountered in which the etiological factors remain obscure for the present.

Pathology—*Gross Anatomy*

As in osteogenic sarcomata, the gross anatomy of giant cell tumors depends largely upon the destructive and productive processes of the involved bone. The tumor tissue during its period of growth constantly destroys the bone while the periosteum lays down an advancing shell of new bone, thus preventing the tumor mass from an early perforation of the bone and an involvement of the adjoining structures. It is due to a combination of these two opposing reactions of the involved bone that the giant cell tumor is an expansible but not infiltrative or invasive lesion encapsulated in a bone shell. Eating its way into the bone, the tumor tissue destroys the bone from within the medullary cavity, gradually

Fig. 77. Courtesy of Warren Museum, Boston. A macerated specimen showing the skeleton of a giant cell tumor. It shows the sharp limitation and general expansile character of the tumor. Notice the extension over the top of the fibula without involvement of the latter. In some cases the tumor enters the fibula by way of spreading the ligamentous attachments between the bones (Plate 35). A partial pathological fracture is seen.

expanding the old cortex, while a few more or less thick bony trabeculæ running in various directions line the cystically expanded bone shell simulating beams supporting the whole structure. It is this structure that causes the most characteristic "soap bubble" appearance in the roentgenogram. The structure of a skeleton of a giant cell tumor is best studied in the macerated and dried specimen when the soft spongy tissue is removed (Fig. 77). Thus the investing capsule of the giant cell tumor is furnished by the new formed bone shell and the periosteum. The latter, while distinctly thicker and more vascular than on the adjoining uninvolved cortex, does not form, however, the abrupt elevation, the periosteal lipping, which is so typical of osteogenic sarcoma. When nothing interferes with the advancing growth of the tumor, the bone shell may be gradually thinned and finally entirely disappear in places. Long after the bone shell is thus perforated the periosteum still continues to envelop the tumor until a very advanced development of the tumor or a pathological fracture hastens the perforation of the periosteal capsule. This is in marked contrast to a malignant bone tumor where the perforation of the bone and periosteum occurs very early. Another factor leading to perforation of the periosteum in giant cell tumor is an exploratory incision although followed by suture of the periosteum. On a longitudinal section through a giant cell tumor

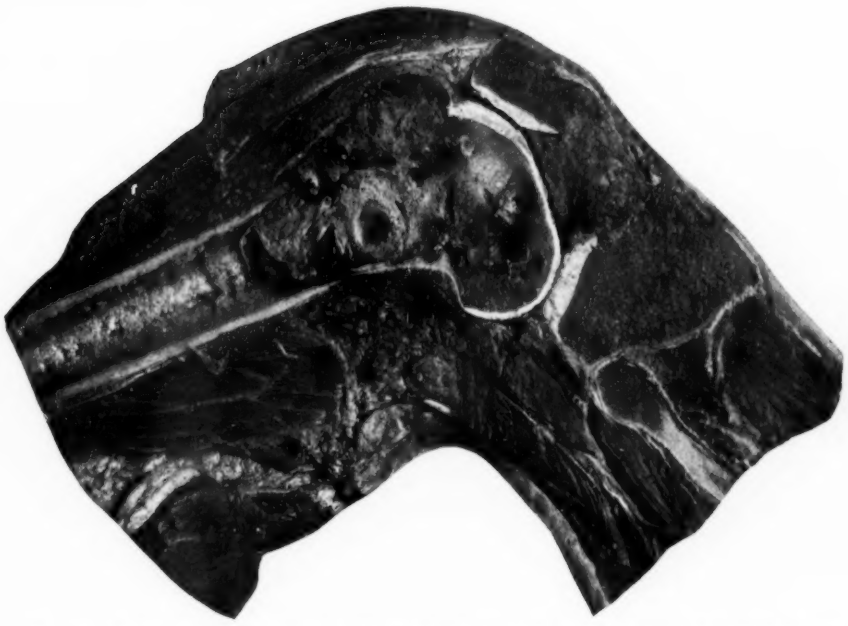


Fig. 78. Case 454. Same case as that in Figure 84. Giant cell tumor in a man 28 years old. The arrow points to the limiting membrane of the lesion, toward the medullary cavity.

one occasionally recognizes grossly a limiting membrane toward the medullary cavity; a thin layer of brown whitish tissue beyond which the normal spongiosa or bone-marrow can be seen (Fig. 78).

The articular cartilage is very resistant in giant cell tumor as it is in osteogenic sarcoma. It is most unusual to see the articular cartilage destroyed by tumor tissue even in the advanced stage. Usually the spongiosa lining the articular cartilage from within the medullary cavity is entirely destroyed and the cartilage is in immediate contact with the tumor tissue (Plate 34). In such a proximity of the tumor to the joint cavity one may find the synovial membrane slightly thickened, œdematous, of brownish yellow color. It is not unusual to find some clear exudate in the joint cavity. An actual direct involvement of the joint cavity by tumor tissue is even less frequent than in osteogenic sarcoma; it occurs in pathological fractures and in very advanced cases. It is not unusual, however, to see an indirect involvement of the joint cavity by tumor spreading along intra-articular ligaments, for instance along the ligamentum teres femoris or ligamenta cruciata. The same manner of growth of the tumor, by spreading the lamellæ of ligaments, one sees also in involvement of an adjoining bone when the ligamentous attachments between the bones usually serve as a bridge for the

Plate 34. Case 580. Giant cell tumor. The roentgenogram was taken before amputation. The extent of involvement in giant cell tumor is always greater than it appears from the roentgenogram. The apparent limitation of the tumor to the external condyle is misleading as is seen from the photographs. Above, right, section through the external condyle; it shows the intact articular cartilage, while the entire condyle is displaced by the lesion. Below, right, section through the internal condyle.

tumor (Plate 35). This way of expansion of the tumor along lines of lesser resistance is also observed in the process of perforation of the periosteal investing capsule where the layers of the periosteum are spread by the ingrowing tumor tissue; it is also seen in the spreading along fascial planes of the tumor mass projecting into the soft tissue after periosteal perforation. In far advanced and large giant cell tumors the expansion of the bone shell is interfered with by the surrounding tendons and ligaments, so that occasionally the roentgenogram, but more frequently the dried specimen, shows grooves in the bone shell through which the individual tendons ran (Fig. 79).

The gross appearance of the giant cell tumor depends greatly upon the phase of the lesion. The typical giant cell tumor consists of solid portions and numerous small cysts. The solid portions are very friable, crumbly, somewhat granular masses, varying in color from yellow and light brown to dark red. On incision the tumor tends to extrude like granulation tissue. The texture of the growth becomes more dense with the approximation to the periphery and capsule. This vascular, soft, readily oozing, and frequently profusely bleeding tumor, resembling currant jelly, is entirely confined within the bone shell; it lies there loosely and can be easily scooped out by a curette. With the aging of the tumor or after radiation therapy the tumor mass enters a cicatrizing phase. The reddish jelly-like tumor mass changes gradually, beginning at the periphery, to a more opaque and firm mass, while in the central portion the old juicy stroma prevails. With the advancing differentiation of the tumor tissue, fibrosis in all stages to fibrosis and cicatricial tissue may be seen. Some varieties of giant cell tumors may be solid and firm throughout from the commencement and because of their frequent peculiar yellow color due to the presence of lipoid material they have been designated as xanthomata. The variety of giant cell tumors which, according to Wright and Ewing originates from absorbing of aberrant cartilaginous islands, shows the presence of various sized foci of cartilage distributed in the giant cell tumor mass. The various phases of giant cell tumor are a result of advanced differentiation of the soft immature tumor tissue. All successive processes of repair can be traced here. Such a differentiation is especially marked in well advanced cases. A pathological fracture through the tumor or radiation therapy, as well as an incomplete surgical curettage, may give rise to a cicatrization of the tumor. When a giant cell tumor is complicated by a fracture the soft hæmorrhagic giant cell tumor tissue is replaced by active fibrosis which is followed by peripheral ossification. Usually, however, the outer part of the tumor alone is fibrosed, the central portion remaining in its immature stage or being replaced by a fluid containing cyst. The firm, dry, fibrosed peripheral portion may show osteoid tissue formation and even ossification.

At the suggestion of Ewing an attempt has been made to differentiate several varieties of giant cell tumors which differ from the typical tumor grossly as well

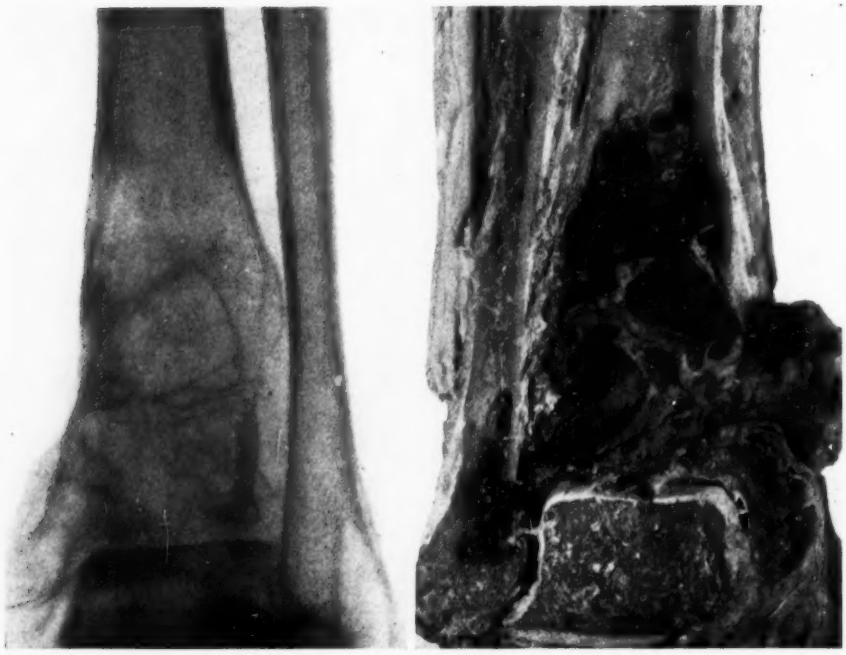


Plate 35. Case 212. Giant cell tumor in a man 24 years old. Curettage on several occasions led to a persistent sinus with tumor sprouting through it. The roentgenogram was taken before the amputation, 2 years and 2 months after the onset. The roentgenogram and especially the photograph show the spreading of the tumor along the tibia—fibular attachment into the fibula.

as histologically. Thus, as xanthoma is designated a variant of giant cell tumor in which the presence of considerable fatty detritus lends the tumor a yellow appearance. Another variant is the so-called myxomatous giant cell tumor in which a mucinous matrix is the main characteristic feature. Giant cell tumors in whose texture islands of cartilage are encountered are said to arise from absorption of misplaced islands of cartilage, when the released cartilage cells acquire a neoplastic character. In this variety of giant cell tumor it is not unusual to see extensive areas of calcification about the remnants of cartilage cells. As in osteogenic sarcoma here also the degree of vascularity of the tumor has been laid as a basis of differentiation of a so-called telangiectatic giant cell tumor. Already in a typical giant cell tumor the central portion is made up either of an organizing blood clot or a sinusoidal reticulo-endothelial system filled with grossly intact blood, reminding one of a bloody sponge. When the extensive vascularity is confined not merely to the center of the tumor but is present in the largest portion of the tumor, it then represents the telangiectatic variety of giant cell tumor

(Plate 36). The clinical importance of such a differentiation of variants of giant cell tumor is questionable since there is no sufficient evidence accumulated to support the contention that these variants differ greatly in their clinical course. Furthermore, such variants cannot be distinguished before the tumor is submitted for a pathological examination, gross or histological.

The rich vascularity of giant cell tumor alone suggests the great tendency of the tumor tissue to retrograde change; the frequent presence of blood clots, of old blood pigment, and of areas of hæmorrhage in all stages of decomposition is sufficient evidence of the frequency with which regressive changes occur here. After radiation therapy of a giant cell tumor it is not unusual to see in the central portion extensive necrosis and cyst formation filled with blood clot and serous fluid. The occurrence of cysts in an advanced giant cell tumor is not uncommon. Occasionally the polycystic appearance is very striking. Various cysts, reaching the size of a hazel nut, are confined within chambers formed by brownish septa, at times paper thin and then again of considerable thickness, interwoven among themselves and at the periphery rather firmly attached to the bone trabeculæ of the bone shell. The cysts are filled with blood or chocolate colored fluid (Fig. 80); or an opaque, brownish, or greenish mucinous mass, a greenish or grayish serum; evidently the product of various stages of decomposition of blood extravasations.

Fig. 79. Courtesy of Warren Museum, Boston. A dried specimen of a giant cell tumor of the lower end of the radius. Showing the grooves for the tendons and the ballooning of the styloid process. The nodule at the top of the styloid process apparently belongs to the carpal bones. The patient, a woman, died in 1850 from a natural cause.

Structure

The histological structure of the typical giant cell tumor consists of two leading elements: the giant cells and the stroma. The latter consists of numerous

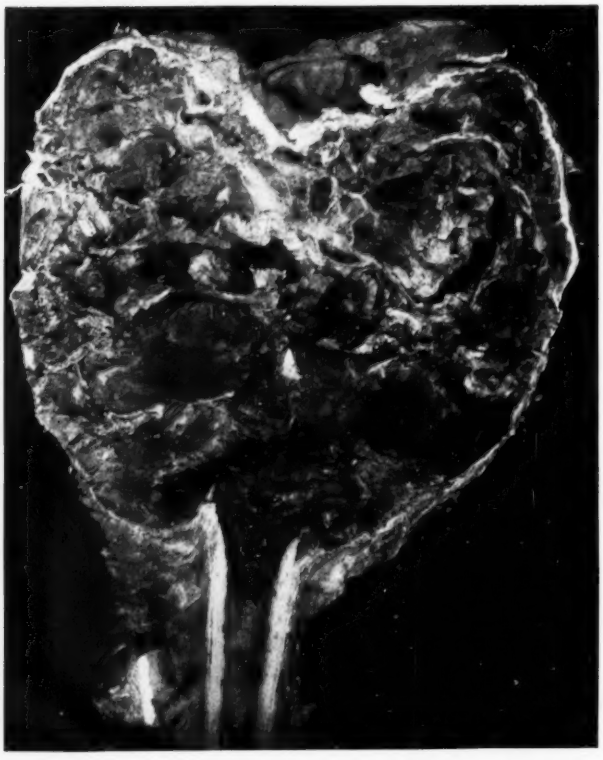


Fig. 80. Case 320. Same case as that in Plate 36. Giant cell tumor of the tibia in a woman 35 years old. Amputation 3 years after the onset. Showing complete absence of a periosteal reaction on the adjoining portion of the uninvolved shaft.

various sized blood spaces and exceedingly thin walled capillaries suspended in a very loosely woven net of spindle, round, or polygonal cells with large vesicular nuclei. One of the most characteristic features of a giant cell tumor is the absence of pleomorphism of the cells of the stroma. This loose cellular tumor mass is very poor in fibrils in contrast with the peripheral portion of the tumor where the differentiation of the cellular elements usually begins first, and where the stroma is poorer in cells but firmer through the abundance of fibrils. In the central portion of the tumor fresh extravasations of blood as well as hæmosiderin can be found; the latter, however, is usually found near the periphery of the bone shell. With the advancing growth of the tumor the blood clot may organize, and the blood pigment is carried away by giant cells and by the abundant endothelial leucocytes sprinkled through the tumor mass. It is in these endothelial leucocytes and not in the cells of the stroma that mitoses are not infrequently observed.

The numerous giant cells are loosely embedded in the stroma (Fig. 81). These are large opaque acidophile cells, resembling normal osteoclasts and containing numerous small oval nuclei uniformly shaped with a chromatin content larger than the nuclei of the stroma cells. The nuclei are grouped in the central portion of the large cells. The histogenesis of this peculiar cell is still a subject of discussion; the theory in vogue at present is that these cells originate from the endothe-

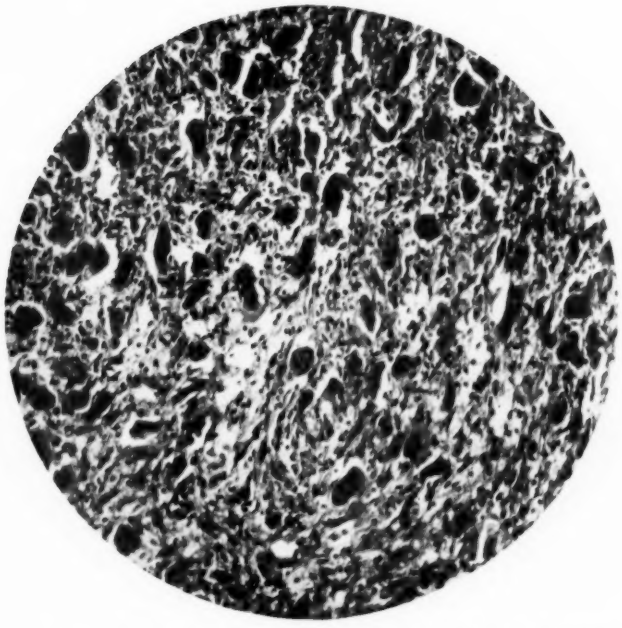


Fig. 81. Case 208. A typical structure of a giant cell tumor. Abundant giant cells of epulis type are loosely embedded in a fibroblastic stroma.

lium. The very intimate relation of the giant cells to the vascular endothelium, the frequent lining of blood spaces by giant cells, and the tracing of the formation of giant cells to the proliferative vascular endothelium seem to support Lubarsch's view of the giant cells as abortive vascular sprouts. Mallory believes the giant cell to be a product of fusion of endothelial leucocytes in the presence of calcium salts absorption. In a study of the giant cells as they are seen in various stages of giant cell tumors one can trace their composition from smaller cells as well as their splitting up in cells with single nuclei. Apparently after the need for the giant cell has passed they have a tendency to disunite. Frequently, however, one sees the retrograde changes leading to the terminal end—death of the giant cell. Minute clefts and small vacuoli appear in the cytoplasm; the latter are probably traces of fatty detritus which was phagocytized by the giant cell and removed from the cell in the course of the histological preparation. If the cytoplasm has not disappeared in the process of splitting up of the individual nuclei, it may remain as a dead, faintly stained clump of cytoplasm riddled with vacuoli and shadows of the nuclei. Such cytoplasm may break up in small débris and be finally removed from the tumor by other phagocytes (Plate 37, frontispiece).

Plate 36. Case 320. Same case as that in Figure 80. Giant cell tumor in a woman 35 years old. Radiation was attempted but unsuccessfully, apparently because of the immense size of the tumor. Amputation 3 years after the onset. Showing the huge blood spaces in relation to the main blood vessels.

Fig. 82. Case 142. Giant cell tumor. Showing the net-like structure of the spongy tumor with the giant cells playing an active rôle in the texture of the tumor.

There is at present much discussion whether the giant cell is an integral part of the tumor or merely a side product called forth for the scavenger work in the lesion loaded with decomposing material. Whatever opinion one may hold, one cannot deny that the structure of a typical giant cell tumor with the abundant giant cells tied up like knots at the junctions of endothelial strands suggests that the giant cells play an important rôle in the composition of the tumor (Fig. 82). It is true that, when needed, the giant cells take up the function of scavengers and it is not uncommon to find in giant cells fatty detritus, remnants of blood cells, blood pigment, and even small spicules of bone.

Apart from giant cells one may occasionally encounter in the stroma of a giant cell tumor a lymphocytic and myelocytic infiltration which is not unusual for a medullary lesion. In tumors of long standing one sees an advanced differentiation of the fibroblastic stroma entering a cicatrizing and fibrosing stage. Such a differentiation may be hastened by radiation therapy or by a spontaneous fracture through the tumor. Usually the differentiation proceeds from the periphery to the center of the tumor but occasionally one encounters a differentiation in islands in the middle portion of the tumor while the more peripheric portions

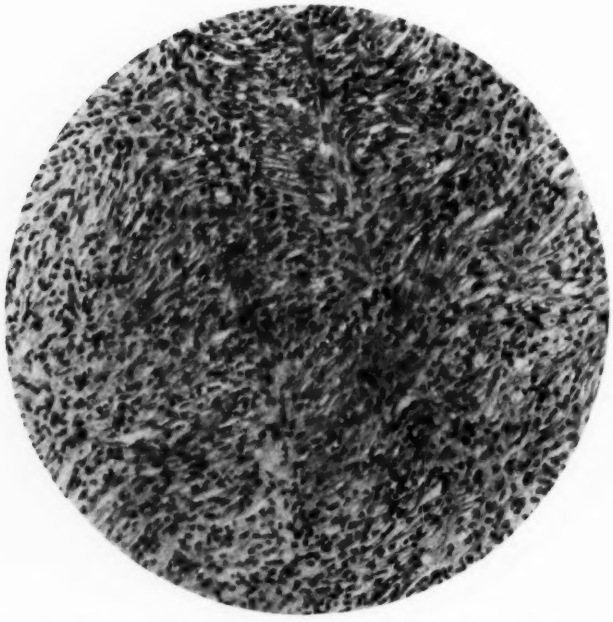


Fig. 83. Case 103. Giant cell tumor; cicatrizing and fibrosing stage. The stroma is represented by a dense fibrous tissue poor in giant cells.

temporarily remain immature. The spindle fibroblasts become smaller; fibrils appear about them, and soon the stroma is represented by a dense fibrous tissue poor in cells (Fig. 83). Osteoid tissue formation and metaplastic ossification can be expected here.

To avoid errors in diagnosing a giant cell tumor from the histology one has to keep in mind the various deviations from the typical giant cell tumor structure. Probably the most frequent variation of giant cell tumors is the so-called xanthoma, when the resorption of a considerable amount of fatty detritus leads to an impregnation of the phagocytozing cellular elements with lipoids. Typical giant cells are few there, and their place is taken by aggregates of endothelial leucocytes which are peculiar here because of the fairly granular cytoplasm resulting from the lipoid inclusions. These are the so-called "foam cells" (Fig. 84). A deviation from the typical giant cell tumor is also observed in the myxomatous variation, the peripheral portion of which consists of spindle cells, slightly smaller in size with a large chromatin content of the nuclei, embedded in a mucinous mass (Fig. 85). The central portion may retain all characteristic features of the typical giant cell tumor and even show areas of spontaneous healing with hyalinization and calcification (Figs. 86, 87).

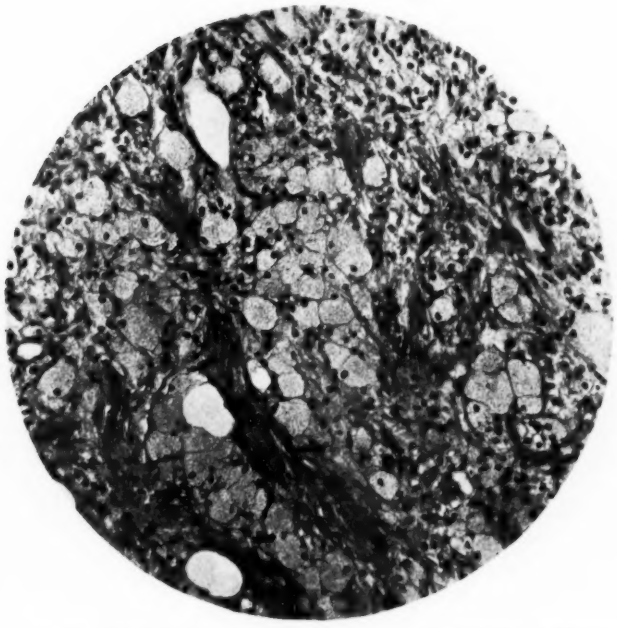


Fig. 84. Case 454. Compare with Figure 78. Giant cell tumor; xanthoma variety. Showing the "foam cells" filled with lipoid inclusions.

The variety of giant cell tumor originating in connection with an absorption of misplaced islands of cartilage, presents a marked deviation from the normal structure. Along with areas of degenerating cartilage undergoing absorption and calcification newly formed, imperfect cartilage cells can be seen as polyhedral granular cells arranged in sheets and clusters. At a glance they somewhat resemble epithelial cells and the name "epithelioid cells" has been suggested for them (Fig. 88). The degenerating cartilage is hyaline or dark staining fibrillar material. The spindle fibroblastic structure is absent here and a very cellular stroma composed of rounded cells gives the tumor the general aspect of a myeloma (Fig. 89). There are a few giant cells scattered in the cellular areas, especially about extravasations and blood spaces.

Unlike malignant bone tumors, in which the destruction of the involved bone is accomplished by both osteoclasts and tumor cells, in giant cell tumors the task of destruction of the cortex is taken over by the giant cells. The destruction of the bone shell by the giant cells from within and the apposition of new bone by a dense row of osteoblasts beneath the periosteum from without can be easily seen in section (Fig. 90). In the areas where the struggle between the giant cells

Fig. 85. Case 592. Same case as that in Figures 86 and 87. Giant cell tumor. This section was taken from the periphery of the tumor. Showing the myxomatous structure of the tumor.

and the osteoblasts resulted in a complete destruction of the bony capsule, the giant cells retreat from the advance guard of the tumor and the number of giant cells along the periosteal investing capsule is smaller than when remnants of bone were lining it (Fig. 91). The periosteum remains intact for a long time, forming the last wall of defense before the tumor breaks through into the surrounding soft tissues. Nothing contributes more to the hastening of such a perforation than an exploratory incision or incomplete curettage. Once incised the periosteal capsule remains open and disabled in its effort to encapsulate the tumor.

When a recurrence has taken place in a giant cell tumor the histology shows a variable picture and is always of an altered character. Cicatrization of a giant cell tumor may be hastened occasionally by incomplete curettage and sometimes even by an exploratory incision, provided infection does not set in. Frequently, however, infection is not avoided and the infected fungating pulsating masses of the tumor acquire an appearance of a malignant new-growth. Histologically such a giant cell tumor is greatly changed by the admixture of a reaction to infection and by stimulation to active growth.

Fig. 86. Case 592. Compare with Figures 85 and 87. This section was taken from the central portion of the tumor. Typical structure of giant cell tumor.

Clinical Course

The clinical incidence of giant cell tumors is apparently lower than that of primary malignant bone tumors. If one judges from the material of the Registry, the relative frequency of giant cell tumors as compared with malignant bone tumors is about 1:2. This ratio is probably an exaggeration of the frequency of giant cell tumors, since the Registry material counts many cases in which the patients were alive at the time the Registry began, while the average life duration of a patient with a malignant bone tumor is about 20 months. The giant cell tumor is more frequently met with in the female than in the male; the ratio 6 to 5 is probably a fair expression of this frequency. The age in which giant cell tumor is most frequently encountered is expressed by the adjoining histogram (Fig. 92). It is in the decade between 16 and 25 that most giant cell tumors occur, an age considerably higher than for osteogenic sarcoma and Ewing's sarcoma. In 28 per cent of females the disease occurred after the age of 30 as against 41 per cent in males. The youngest patient was a girl of 6 and the oldest a man of 68.

The location of the giant cell tumor is in marked contrast to that of osteogenic sarcoma as far as the bone and the site of involvement is concerned. The bones of

Fig. 87. Case 592. Compare with Figures 85 and 86. Showing areas of spontaneous healing with hyalinization and calcification.

the lower extremity were involved in 56 per cent of all cases of the Registry while those of the upper extremity were involved in 23 per cent of all cases; in 21 per cent of all cases the bones of the trunk including the pelvis and shoulder girdle and the jaws were involved. Of all the cases of involvement of the upper extremity the radius was involved in 40 per cent, all in the lower end of the bone. The femur was involved in 57 per cent of all cases of giant cell tumor of the lower extremity and the tibia in 36 per cent. The lower end of the femur was, as a rule, involved, with very few exceptions, when the tumor was situated in the upper third of the femur about the trochanters. The lower end of the femur is involved much more frequently in the male than in the female while an involvement of the upper end of the tibia, which is three times as frequent as that of the lower end of this bone, is seen more frequently in women than in men. In general in about 47 per cent giant cell tumors were situated in the lower end of the femur and the upper end of the tibia. The jaws were the seat of the tumor in about 9 per cent of all cases, the spine following closely with 8 per cent of all cases of involvement. Involvement of the jaws which is equally distributed between the upper and lower jaw, is apparently rare after the age of 25. The shaft of the long bones was involved in two cases, while in both these cases there was place for doubt as to the

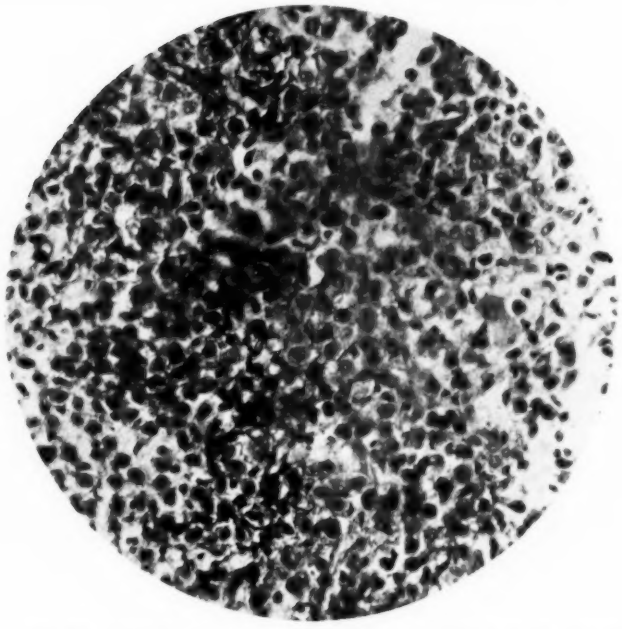


Fig. 88. Case 5. Same case as that in Figures 89 and 98. Giant cell tumor. Showing the "epithelioid cells."

accuracy of the diagnosis since a cyst complicated by fracture could not be ruled out. Giant cell tumor is situated in the small bones of the extremities more frequently than osteogenic sarcoma. In contrast with osteogenic sarcoma, in which the epiphysis frequently escapes involvement because of the epiphyseal cartilage serving as a barrier to the spreading tumor, in giant cell tumor the epiphysis is involved in the large majority of cases. Here the epiphyseal cartilage does not seem to exert any influence upon the spreading of the tumor and the latter frequently extends from here into the diaphysis. When the tumor is situated in the lower end of the femur or the upper end of the tibia, frequently one condyle or one tuberosity is involved; the tumor may spread into the diaphysis leaving the opposite condyle or tuberosity uninvolved. As a rule the giant cell tumor appears as a solitary lesion and it would seem probable that in some of the cases of multiple giant cell tumors one is dealing with a proliferative osteitis fibrosa.

The importance of trauma as an etiological factor in giant cell tumor has been mentioned above. If one is careful in gathering the facts of the patient's history, one very frequently encounters an antecedent local injury. In giant cell tumor of the jaw it is not uncommon that after a loose tooth is pulled a giant cell tumor develops; in such cases the injury apparently plays a stimulating rôle in the growth

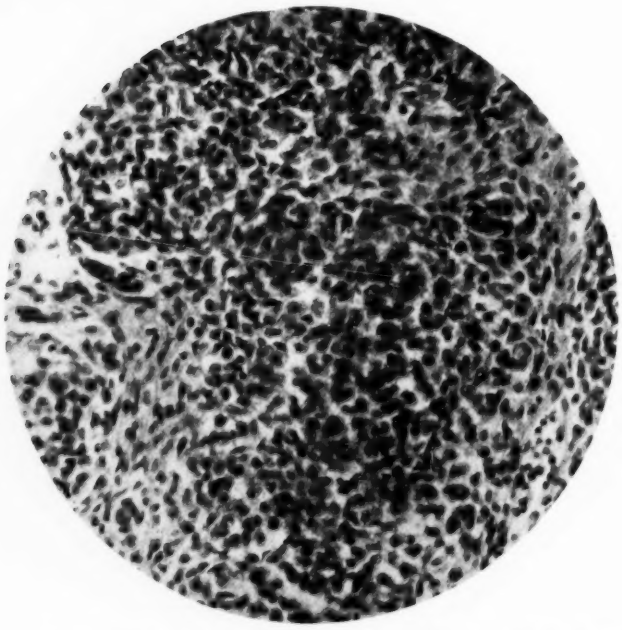


Fig. 89. Case 5. Compare with Figures 88 and 98. The cellular stroma consisting of round cells reminds one of myeloma.

of the tumor. Pain is frequent and early complained of by a patient afflicted with giant cell tumor. The pain, however, is of less severity than in osteogenic sarcoma, and it is more persistent after radiation therapy is begun. The patient's general condition usually remains good unless an exploration or incomplete curettage was done accompanied by infection. Infection is very persistent in giant cell tumor and it may lead to sepsis in a brief period of time. The skin frequently lacks the dilated veins commonly seen in osteogenic sarcoma. When the skin is very distended by the large tumor, it may resemble pig skin, be œdematous and cyanotic. Ulceration of the skin occurs apparently only in the very far advanced cases which have long gone without medical attention.

Palpation is an important diagnostic aid in the examination of a giant cell tumor. Frequently one is able to palpate the bony capsule of the tumor and its borders at the junction with the uninvolved diaphysis. One feels the bulky spheric shape of the tumor as contrasted with the fusiform shape of the osteogenic sarcoma. It is much easier to palpate in giant cell tumor because of relative absence of tenderness. When the bone shell of the tumor becomes very thin, egg-shell crackling can be made out. In the very vascular variety of giant cell tumors one occasionally feels a bruit. As a rule giant cell tumor is of long duration

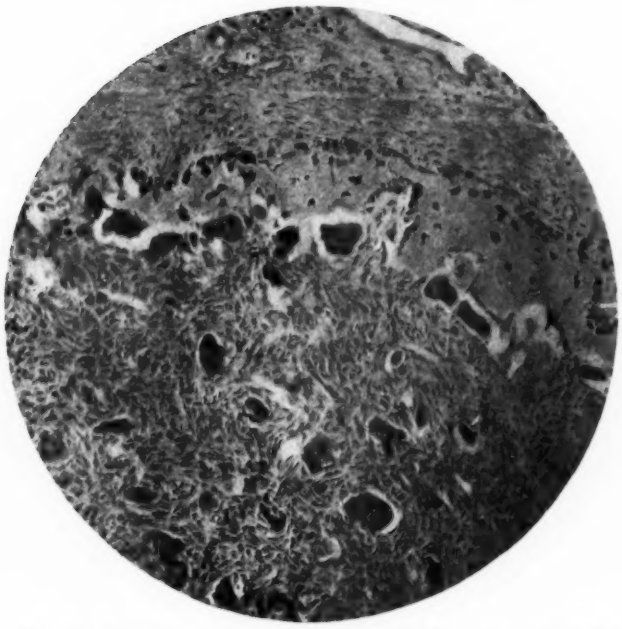


Fig. 90. Case 235. Same case as that in Figure 91. Giant cell tumor. Showing the destruction of the bone shell by the giant cells from within and the apposition of new bone by rows of osteoblasts beneath the periosteum.

and slow growth; notable exceptions are known however. At the present day advanced stages of giant cell tumors are seldom seen since their growth is interrupted by surgery or radiation. Occasionally in long standing tumors attempts at spontaneous healing occur,—cicatrization with ossification of the peripheric portion and cyst formation in the center. When infection takes place fatal hæmorrhage and sepsis may ensue. After breaking through the investing capsule the tumor travels along the intermuscular and fascial planes but does not invade the muscle tissue. In giant cell tumors of the spine a compression myelitis may offer an orthopedic issue. Frequently such patients die from supposed sarcoma while occasionally they can be saved by orthopedic measures. Infraction is almost a rule in giant cell tumor, especially in the weight bearing bones, where also complete pathological fractures are frequent. This fact again emphasizes the necessity of splinting and recumbency. The pathological fracture of the lower extremity is usually of the telescoping variety, with one end of the bone projecting into the cystically dilated other end. Joint involvement is exceedingly rare. When it occurs it frequently is due to undermining of the articular cartilage, which process is followed by collapse of the joint and rupture of the tumor into it.

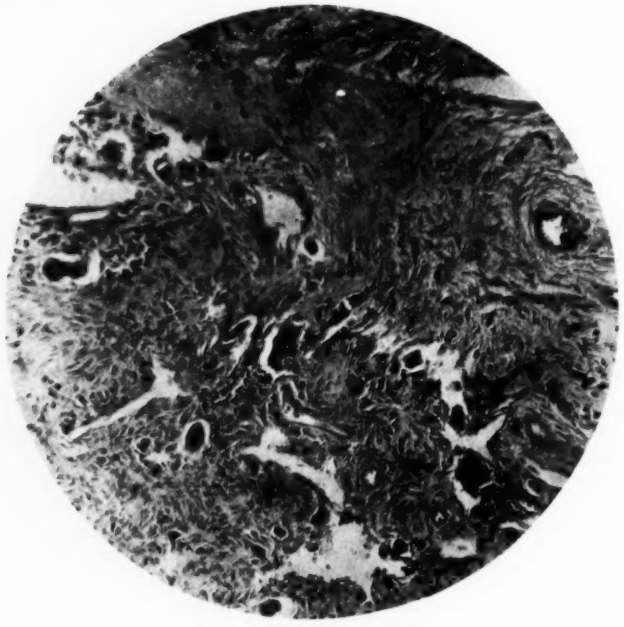


Fig. 91. Case 235. Compare with Figure 90. When the bone shell is destroyed the giant cells retreat from the advance guard of the tumor, and the number of giant cells along the periosteal investing capsule is scarce.

Diagnosis

Most of the general points in diagnosis outlined in the chapter on osteogenic sarcoma are applicable also in relation to giant cell tumors. While some experienced observers maintain that it is always possible to arrive at a diagnosis in giant cell tumor from a microscopic examination of the section alone, and others claim that the clinical history together with the physical findings and roentgen-ray features will suffice for diagnosis without an exploration of the tumor, there are times when neither method of examination, clinical and radiological, or microscopic, nor both of them combined will suffice for an accurate diagnosis. These cases are rare, frequently they are complicated by previous surgical treatment. These are the cases referred to by Ewing as the "borderline" giant cell tumors, with a wide destruction of bone, with an absence of the bone shell with smaller than usual giant cells containing larger and more hyperchromatic nuclei; they present a difficult task for the pathologist especially when diagnosis is requested from small curetted pieces of tissue. It is with reference to these cases that Platou said: "It is deplorable that a microscopic examination sometimes permits only of a probable

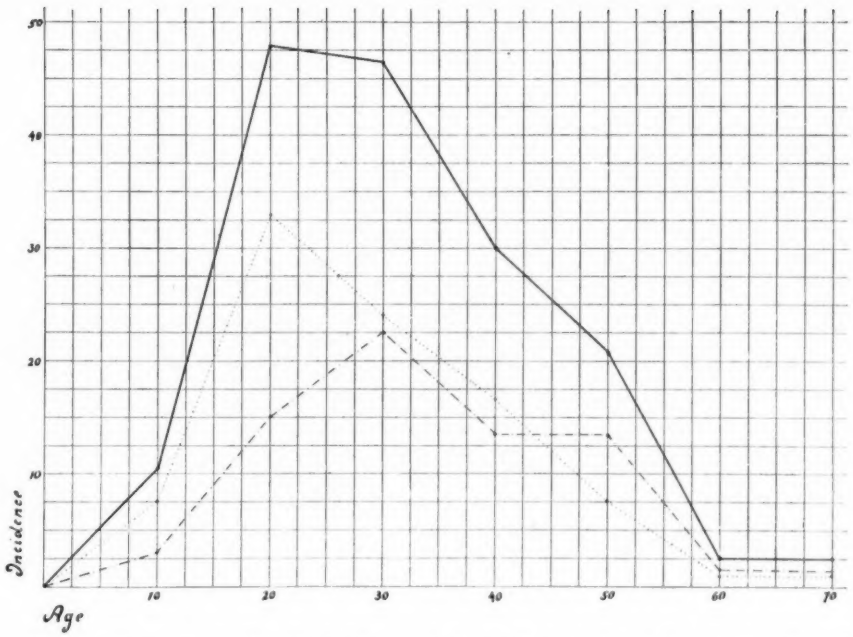


Fig. 92. Curve illustrating the incidence of giant cell tumor in relation to age. Dotted line—females; broken line—males; heavy line—both sexes combined.

diagnosis." Despite this fact it should not be understood that in general the diagnosis of giant cell tumor requires all available data together with an exploratory incision. To the careful observer a complete history and thorough physical examination, supplemented by satisfactory roentgenograms, will suffice for an accurate diagnosis in the majority of cases.

In attempting a diagnosis of giant cell tumor from the clinical findings alone, one should remember that the most frequent error is mistaking it for osteomyelitis; this is at least not less frequent than mistaking it for an osteogenic sarcoma. Because of the location of giant cell tumor in the ends of long bones and also because of its long duration and slow progress, it is the tuberculous osteomyelitis and the tuberculous joint involvement with which one is mostly concerned in such cases. This is especially true when, as it frequently happens, the giant cell tumor is situated about the knee joint. The asymmetric enlargement of only one side of the region of the knee joint and not of the whole area as in tuberculosis, and the absence of the fusiform swelling of the joint, which is frequent in tuberculosis, are strong differentiating points. To depend entirely upon the laboratory specific tests for tuberculosis is not recommended because of their frequent failure as an accurate diagnostic means. In a patient who later died of an osteogenic sarcoma

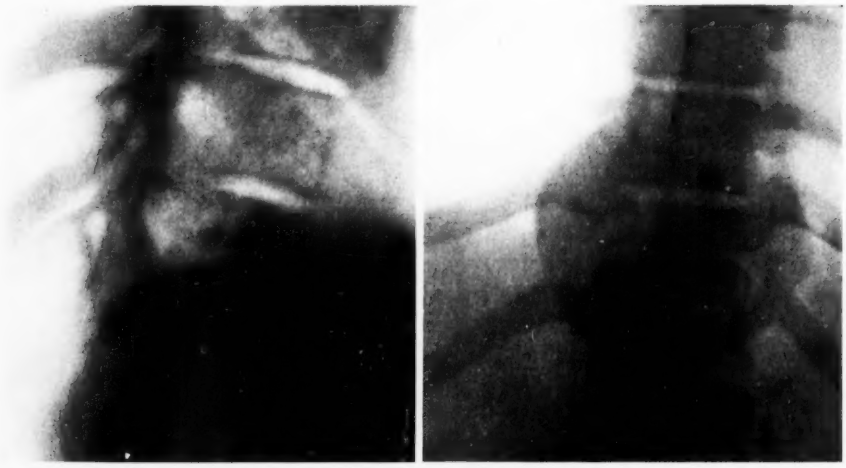


Plate 38. Courtesy of the Ruptured and Crippled Hospital, New York City. Primary sarcomatous tumor of the spine. The tumor arose in the tenth dorsal vertebra which is extensively destroyed while the intervertebral discs remain intact.

without evidence of tuberculous involvement at autopsy, I have seen, following an intradermal tuberculin injection, a positive local, focal, and general reaction. Giant cell tumor of the spine is frequently confounded with tuberculous spondylitis. Nervous disturbances as a result of pressure on the spinal cord and nerve roots are likely to appear earlier in a tumor involvement than in tuberculosis. The pain is of more or less intermittent character in the beginning of the disease and abscesses are absent even in well advanced stages of the tumor. While in Pott's disease the intervertebral discs are destroyed early, in giant cell tumor and also in osteogenic sarcoma and Ewing's sarcoma the destruction of the vertebral body greatly precedes that of the discs (Plate 38). Another sign of giant cell tumor of a vertebra, which is especially significant in the presence of a malignant tumor, is œdema of the soft tissues overlying the involved area of the spine.

The outstanding diagnostic importance of the radiological examination goes without saying. To be of real value and not misleading, the roentgenogram must be irreprehensible. All the important technical points mentioned in the chapter on osteogenic sarcoma are true also here. Repeated radiological examination of skeletal tumors from many angles is indispensable for an accurate diagnosis. The roentgenogram is frequently of more importance than a microscopic examination when a variant of giant cell tumor is dealt with; so for instance in cicatrizing giant cell tumor the histology will be that of a fibrosarcoma but the roentgenogram will be typical of a giant cell tumor.

The radiological appearance of a giant cell tumor is most characteristic (Figs. 93 to 100). It usually casts a bulky spherical shadow showing a multicystic

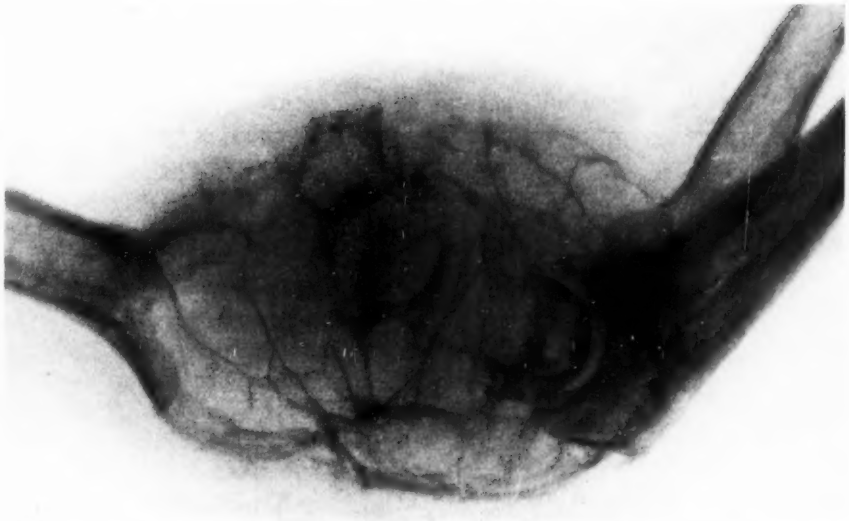


Fig. 93. Courtesy of Memorial Hospital, New York City. Typical roentgenogram of a giant cell tumor.

appearance as a result of the osseous trabeculation in the periphery. The shaft of the bone is absent and it appears as if the cortex is blown out from within the medullary cavity so as to form the thin bone shell, which sharply limits the tumor from the surrounding soft tissues. Beyond the tumor the cortex and the periosteum are entirely unaffected and no periosteal lipping is seen. In the clear roentgenogram an apparent continuation of the bone shell is seen limiting the tumor from the adjointing unaffected medullary cavity; this shadow is an important diagnostic feature and deserves much attention. Not infrequently this borderline shadow is not seen in the roentgenogram because of unsatisfactory technique. To show it requires care in adjusting the position of the tube in relation to the tumor and a rather exacting localizing technique. When the diaphyseal end of the tumor is brought into the field of central rays of the tube it is rarely missed. When in advanced cases of giant cell tumor the bone shell is destroyed, in some areas the roentgenogram will simulate an invasion of the tumor into the soft tissues in spite of the intact periosteum; it should be remembered, therefore, that such a break in the continuity of the bone shell is not a sign against giant cell tumor. When the whole bone shell is destroyed it may be difficult to differentiate it from osteogenic sarcoma but frequently roentgenograms from various angles together with palpation and the clinical history will help in the diagnosis. The fact that the adjoining periosteum and cortex remain unaffected speaks strongly against osteogenic sarcoma. Usually one or another view of the tumor in the roentgeno-

Fig. 94. Courtesy of Memorial Hospital, New York City. Typical giant cell tumor.

gram will show in osteogenic sarcoma the shaft running in the tumor, while in giant cell tumor the shaft is absent. An important differentiation point is also the fact that in osteogenic sarcoma the tumor does not reach the articular cartilage, a layer of spongiosa a millimeter or two in thickness remaining between the tumor and the cartilage, while in giant cell tumor, the tumor is in direct contact with the cartilage. Another condition which requires ruling out in the diagnosis of giant cell tumor is bone cyst. In the majority of the cases this is, however, not difficult. A cyst is intra-osseal and expands the bone only slightly. The cortex of the bone at both poles of the cyst is thinned out so that there is gradual thinning of the cortex from the poles to the middle of the cyst and not an abrupt transition of the normal cortex in a greatly expanded thin trabeculated shell as in giant cell tumor. A cyst is mostly located in the shaft, while a giant cell tumor is in the ends of long bones. The situation of the tumor is not infrequently decisive; if a tumor is in the condyle of the femur or in the tuberosity of the tibia and before breaking through the shaft it extends into the diaphysis, a giant cell tumor is to be considered. It is generally believed that in children a spontaneous fracture as a symptom of onset in a central lesion is characteristic of a cyst and not giant cell tumor. Occasionally a far advanced fibrocystic lesion, when it expands to the epiphyseal and of the bone, may suggest a diagnosis of giant cell tumor. However, in osteitis fibrosa cystica, while the involvement extends far along the shaft, it is not accom-

panied by a corresponding expansion of the bone in transverse diameter, as is seen in advanced giant cell tumor. Osteitis fibrosa is more apt to occur in old than in young people (Figs. 101, 102).

When combined with the clinical history, physical findings and radiological features, the data of a pathological examination are of valuable diagnostic importance. The main sources of error in the diagnosis of giant cell tumor from the histology should be mentioned here. It may be safely argued that to one experienced in the pathology of bone tumors the gross anatomy of a giant cell tumor will frequently mean more than the histology, and a diagnosis from the gross specimen will be more apt to be accurate than when the diagnosis is based upon the slides alone. It is well to remember that an occasional tumor, however, can resemble grossly or histologically a giant cell tumor and not be one. The histology is frequently misleading in giant cell tumor; especially so when a frozen section is relied upon, as often happens. The diagnosis of giant cell tumor from the section must not be based upon the presence of giant cells alone; the type of the supporting tumor cell is most important. Although the giant cells are an integral part of the giant cell tumor they are occasionally encountered also in typical osteogenic sarcoma where lime salts are set free by rapid erosion and disintegration of bone. This fact is not realized sufficiently by the average surgeon and pathologist who have only a casual acquaintance with the pathology of bone tumors, and it is a con-

Fig. 95. Courtesy of Memorial Hospital, New York City. Typical giant cell tumor.

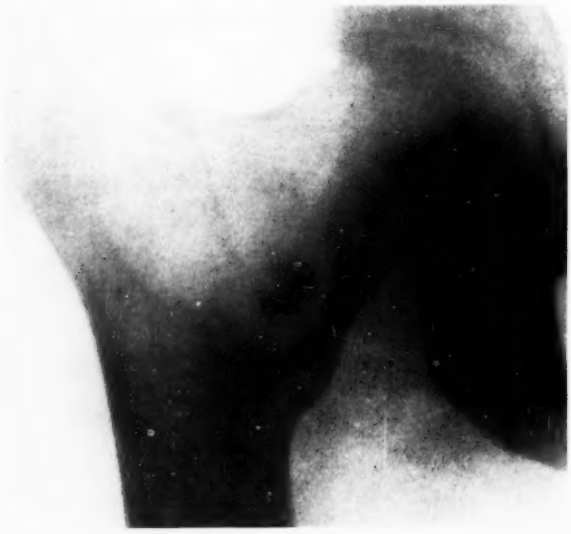


Fig. 96. Case 295. Same case as that in Figure 97. Giant cell tumor in a man 25 years old. This roentgenogram was taken at the time of onset.

stant source of grave errors. Another fact which is not sufficiently realized is that very vascular, so-called telangiectatic osteogenic sarcoma may resemble grossly vascular giant cell tumor. There also one finds giant cells of the epulis type about extravasations. The histology is not infrequently misleading in the variants of giant cell tumor. So, for instance, in the myxomatous variation the histology may suggest malignancy while the clinical findings and radiological features clearly indicate the benign nature of the lesion. In cartilaginous giant cell tumors in a few cases a diagnosis of myeloma has been returned by the pathologist because of the abundance of rounded cells of the stroma. The advanced cicatrizing stage of giant cell tumor may suggest fibrosarcoma, if other data are disregarded. Occasionally several variants may be found in the same tumor. The histology is especially deceiving when the tissues were taken from tumor masses fungating through a former exploratory incision. It is extremely hazardous to base a diagnosis on findings from these granulation tufts. The numerous mitoses here are mostly in the endothelial leucocytes.

The question of indication and contra-indication of biopsies in giant cell tumor is still under discussion. It would seem that the whole question is merely a part of the general problem of the advisability of a biopsy in bone tumors of doubtful nature, since the necessity of exploration indicates that one is not certain whether the tumor is benign or malignant. The difficulties encountered in a diagnosis from the histology in a doubtful giant cell tumor are great and insurmountable to those little initiated in the pathology of bone tumors. As a general rule, when the clinical findings and the roentgenogram are baffling to the clinician, the histology is also distressing to the pathologist. Whatever one may say about the possibility of increase of malignancy in giant cell tumors by an exploratory incision one cannot deny that the dangers of infection with which such explorations are

Fig. 97. Case 295. See Figure 96. This roentgenogram was taken 1 year after the onset. At that time radiation therapy was instituted which led to a shrinkage of the tumor. The patient is earning his living. This is the largest giant cell tumor in the Registry collection. The radiological features are typical of giant cell tumor.

entailed are very great. The spongy vascular tumor and the exposed bone-marrow are very susceptible to infection, and a cellulitis, suppurative osteomyelitis and septicæmia are not rare after such procedures. However, if a biopsy is done the curettage of the tumor should be completed because a following infection will add greatly to the difficulties of radiation. To be decisive a biopsy should include all parts and not only the periphery of the lesion. The radiation therapeutic test is not of such great importance in giant cell tumor as in osteogenic sarcoma

Fig. 98. Case 5. The same case as that in Figures 88 and 89. Giant cell tumor in a boy of 16. The trabeculation in a giant cell tumor of the upper end of the humerus is usually of a more delicate structure, the involved bone appearing honeycombed.

and especially in Ewing's sarcoma however, we have a differentiating point in the fact that pain in giant cell tumor persists after radiation is begun, while in malignant tumors it is usually relieved sooner. In the rare case of an aggressive, rapidly growing tumor which has reached a far advanced stage when first seen, radiation and perhaps an exploratory incision would seem to be better justified than a direct amputation of the limb with only a probable diagnosis of malignancy in one's mind.

Therapy

While in malignant bone tumors the problem of therapy today is to find a way to relieve the sufferings of the patient for a longer period of time, in giant cell tumor the whole crux of the question is as to choice between various methods of treatment, each of which may lead to permanent cure. The history of the therapy of giant cell tumor is remarkable for the continuous change from radical to more conservative methods of treatment. The almost universally employed amputation of some twenty-five years ago was followed by partial resection which later gave way to curettage; and it was curettage that constituted the standard method of therapy in giant cell tumor until very recently. That spontaneous cures of giant cell tumor occur is sufficiently attested; such instances are probably more frequent than is suspected. Toxin treatment has not been applied as frequently as in malignant bone tumors, the adepts in this method of treatment advocating the use of toxins merely as a prophylactic along with radiation after incomplete surgical operations.

Fig. 99. Case 542. Giant cell tumor in a woman of 49. The seat of the tumor in the lower end of the ulna is uncommon, the lower end of the radius being the favored seat of a giant cell tumor about the wrist.

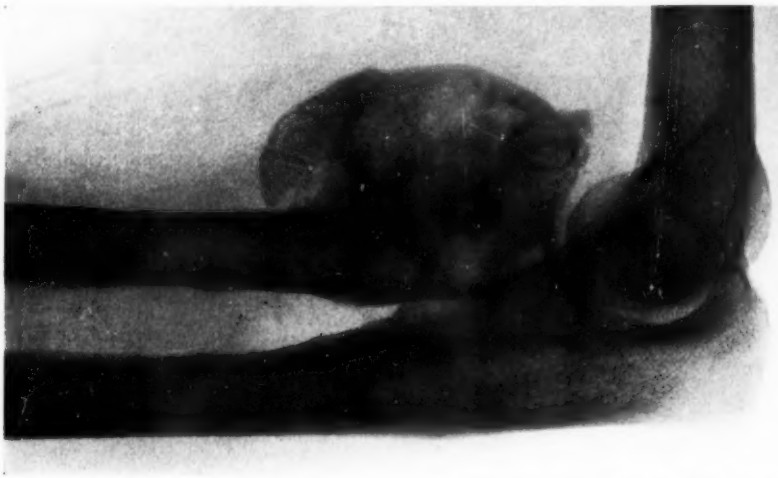


Fig. 100. Case 195. Benign osteogenic tumor. The presence of the shaft of the bone and the fact that the tumor is extracortical speaks against giant cell tumor; the clear cut outline of the tumor speaks against osteogenic sarcoma.

The most frequently employed method of curettage consists of the following procedure: curettage of all removable portions of the tumor followed by swabbing out of the rough curetted area with pure carbolic acid and alcohol, or as some advise, with zinc chloride. The subsequent packing of the cavity with gauze to

prevent hæmorrhage has been given up by some men, who close tightly the operative wound expecting an organization of the blood clot. A promiscuous use of this device in all cases of giant cell tumor should be warned against, since fatal hæmorrhages are known to have occurred. On the other hand if one packs the cavity with gauze, infection is frequent notwithstanding all preventive measures. Whatever the way of dealing with the cavity, the limb should be immobilized to prevent a pathological fracture which will still further complicate the course.

As a prophylactic against a recurrence, radium therapy is to be recommended. Recurrence seems to be frequently unavoidable and is observed in about 20 per cent of all cases treated by a single curettage alone. The cause of recurrence is not known. The histological structure of the tumor gives little explanation of this. The question whether the bone shell is intact or not does not seem to be the decisive factor. That the completeness of curettage has little to do with

Fig. 101. Courtesy of Warren Museum, Boston. Osteitis fibrosa of the tibia in a man of 87. The line of demarcation from the normal bone; the newly formed trabeculæ, the effort of nature to form a buttress behind the bent portion; the intact periosteum and the bowing of the bone are all typical of advanced osteitis fibrosa. Amputation was performed in 1872 by Bigelow.

Plate 39. Case 319. Giant cell tumor in a man 38 years old. Onset in September, 1922. Roentgen-ray irradiation on October 26 and 28, 1922, and on March 13 and 23, 1923. The roentgenograms were taken: October 15, 1922; January 15, 1923; April 18, 1923; May 21, 1924. Function of wrist completely restored.

Fig. 102. Personal observation; not registered. Osteitis fibrosa cystica in a man 68 years old. The lesion was mistaken for a malignant tumor and radiation therapy instituted. Because of an ensuing pathological fracture amputation was done; the histology proved the lesion to be a typical osteitis fibrosa. The wide extent of bone involvement with the relatively small expansion of the bone suggested the diagnosis of osteitis fibrosa from the roentgenogram.

the tendency of the tumor to recur is indicated by the fact that occasionally completely curetted tumors recur while those incompletely curetted go on to a permanent cure. That cauterization is effective only to a relatively small depth is obvious from the chemical coagulative action of the escharotic. In the light of these facts one can never be certain that curettage will not be followed by a recurrence of the tumor. An even greater disadvantage of curettage is infection. This serious complication has occurred in good technical hands and under the best of conditions. The seriousness of infection in a giant cell tumor has been mentioned above. A proven potential danger of repeated curettage of a giant cell tumor is the surgical trauma by itself. I am referring later to the possibility of malignant transformation in rare instances of giant cell tumor after repeated surgical operations and infection.

It has long been known that radiant energy is an active factor as a prophylactic against recurrence of a curetted giant cell tumor. Radiation has for years been used also when the tissue removed during incomplete surgical operations in cases of giant cell tumor seemed to be suspicious. Experience has shown that if radiation is used after curettage no recurrence follows, but the cavity left after curettage does not fill in with new bone and surgery may be the final issue. More disappointing is the experience with radiation therapy of recurrence after curettage. The patient is usually promptly relieved of pain; the infection is checked soon but the growth itself is more refractory to massive radiation. Little bone repair is seen, the scar from the previous operation and even the skin may break down and add considerably to the difficulties of radiation. If curettage has been chosen and done, it should be done repeatedly if recurrences take place, and if necessary, amputation should be considered rather than a change to radiation. Men of wide experience with radiation therapy of giant cell tumor decidedly state that an incomplete surgical operation in giant cell tumor is worse than none.

During recent years a further and most significant step has been taken toward conservative treatment of giant cell tumor; it consists of substituting radiation therapy, either roentgen ray or radium, for surgical operations. It is true that the use of radiation as a primary therapeutic measure in giant cell tumor is not yet widely adopted but the experience accumulated in a few leading medical institutions, especially at the Memorial Hospital in New York, is of such weight that it eliminates any doubt as to the very great value of radiation therapy as a primary therapeutic measure in giant cell tumor, and cases of giant cell tumor cured by radiation are on record. In the reaction of a giant cell tumor to effective radiation therapy one can distinguish two opposite phases. During the first three or four months of radiation therapy the giant cell tumor increases in size, the bone shell expands greatly, becomes thin and finally melts away entirely, the skin becomes reddened, œdematous, inflamed, sore to the touch, and the whole appearance indicates a rapid growth of the tumor. The tumor acquires very suggestive

Plate 40. Courtesy Memorial Hospital, New York City. Giant cell tumor. The roentgenograms were taken (left) before radiation therapy was begun and (right) 3 years and 8 months later.

marks of a malignant sarcoma. This excessive reaction with bone absorption may be avoided by using a less severe radiation dosage. The preliminary reaction of the tumor to radiation is the destructive or negative phase in contrast to the final productive or positive phase of reaction. The latter is characterized by a constant shrinkage of the tumor and by formation of new dense bone. In contrast to the soft and pultaceous consistency of the tumor during the negative phase, it becomes gradually harder in the positive phase of reaction as a result of abundant calcium deposits (Plates 39, 40 and 41). The younger the patient and the more superficial the situation of the tumor the more prompt will be the reaction. In the opinion of those with widest experience, external radiation with roentgen ray or a radium pack is far superior to internal radiation when radium needles are placed into the tumor substance. It is also conceded that the roentgen ray is to be preferred to radium. It is especially dangerous to use unfiltered radium in tumors after curettage; in general, burying unfiltered radium within tumor tissue may lead to bone necrosis, chronic osteitis with abundant sloughs, and infection. The dangers of overradiation should not be underestimated even when external radiation alone is used, when in exceptional cases exposures extending over many months may be followed by radiation changes in the soft parts surrounding the tumor, which may lead to ulceration of the skin, and, in extreme cases, to osteitis with agonizing pain, which may require amputation.

Even if, at the present time, radiation therapy has not as yet become the standard therapy of giant cell tumor there are cases in which only radiation therapy should be considered. This is the case in the giant cell tumor of the spine and in the rare instances of giant cell tumor of the skull. In such cases no complete surgical operation is possible, because of the tendency of the tumor to widely involve the fibrous dense tissue and also of the possibility of a fatal hæmorrhage ensuing after an attempt at surgical removal.

Although the general tendency in recent years has been to substitute conservative surgical procedures and radiation for the radical amputation, the latter, however, cannot be entirely avoided in some rare instances. Occasionally the possibility of a better practical result will decide for amputation rather than curettage. This is sometimes observed when the tumor is situated about the knee, or ankle joint. Infection after biopsy and curettage with suppurative osteomyelitis and cellulitis will make amputation the issue. When the giant cell tumor is exceptionally large the best chance for a cure can be expected from a radical surgical procedure alone since neither curettage nor radiation can cope with the large mass.

In rare instances the histology of the tumor after curettage may appear suspicious enough to call for amputation. Problems in plastic surgery may come up after cure has resulted from curettage in some cases of giant cell tumor of the jaws.

Plate 41. Courtesy Memorial Hospital, New York City. Giant cell tumor with a pathological fracture. Immobilization and radiation therapy instituted. The roentgenogram to to right was taken 22 months after the roentgenogram on the left. The function of the limb is completely restored.

Prognosis

In the preceding chapters I have attempted to stress the importance, in dealing with a giant cell tumor, of a combined evaluation of all data available. This is especially true in relation to prognosis. Only in the light of data accumulated from the clinical history, physical and radiological findings, and pathological examination may a prognosis be given. As in osteogenic sarcoma there are too few cases on record of the giant cell tumor being allowed to follow its natural course without interference by surgery or radiation for definite conclusions as to the natural outcome of such cases to be made. However, there is some evidence on hand to show that when left alone the giant cell tumor may follow one of two ways. Advanced growth of the tumor may lead to fatal hæmorrhage or septicæmia. Occasionally, following a pathological fracture or without it, such a tumor

Fig. 103. Case 349. See Figure 104. Typical giant cell tumor of the tibia. The photomicrograph made from a section of tissue removed at the first operation (curettage).

may enter a cicatrizing stage in which the peripheral portion of the tumor is being converted into a dry, firm, fibrous tissue. The bony shell may become very thick. In the central portion, islands of active giant cell tumor will persist although some of them may degenerate and be replaced by cysts.

The question of the prognosis of giant cell tumor treated conservatively, by curettage or radiation, forms a subject for ardent discussion, and a voluminous literature has grown up about it which unfortunately is somewhat dogmatic on both sides. On one side many cases are cited of giant cell tumor leading to pulmonary metastases and death. Two sources of error of these authors are revealed by a careful study of these cases. The first is that not in all cases mentioned was the primary lesion a giant cell tumor and the second that not in all fatal cases are metastases proven to have been present. On the other hand the authors believe that giant cell tumor is always a benign lesion lacking the ability to produce metastases. The exceedingly few cases of giant cell tumor in which, after repeated surgical operations, pulmonary metastases and death occurred these authors explain by the fact that due to surgical insult and ill advised therapeutic measures the giant cell tumor became transformed into a malignant bone tumor which,

Fig. 104. Case 340. See Figure 103. Structure of the tissue removed from the leg amputated after repeated curettage operations. The histology resembles osteogenic sarcoma. Death with pulmonary metastases.

as a malignant tumor and not as a giant cell tumor, led to pulmonary metastases. It is obvious that such an argument is based solely upon technicalities which do not in the least change the fact that in a tumor diagnosed by experts as giant cell tumor the outcome was death due to pulmonary metastases. That giant cell tumor is essentially a benign lesion is generally conceded. It is benign in the oncological sense of the word although clinically it may offer serious surgical problems. The question as it stands today is whether or not a giant cell tumor is *always* benign. From the evidence on hand this question is to be answered in the negative. Giant cell tumor is essentially a benign condition and there is no case on record in which histologically a typical giant cell tumor gave pulmonary metastases of typical giant cell structure. In the few cases recorded in the literature of death following pulmonary metastases of a giant cell tumor, either both the primary lesion and the pulmonary metastases showed a typical giant cell tumor structure, or the primary lesion was a typical giant cell tumor but the pulmonary metastases were distinctly atypical for giant cell tumor histology. In exceptional cases a giant cell tumor may become a more malignant tumor as a result of repeated irritation—curettage and infection (Figs. 103 and 104).

The main rule that giant cell tumor is essentially a benign lesion is strongly supported by the fact that these exceptional cases are exceedingly rare; inasmuch as the possibility of forcing tumor cells into the blood channels during curettage is very great in so vascular a lesion. Cases have been seen of recovery following resection of a giant cell tumor which on dissection showed the presence of tumor cells growing in a vein. To produce metastases it is not sufficient to have tumor cells in the blood stream; the cells must be sufficiently viable to be able to settle down and to multiply at their new place. But when, after repeated irritations, the tumor cells become more resistant and viable they may acquire malignant features. This possibility that a giant cell tumor may become transformed into a malignant new growth is additional proof that at least in some instances giant cell tumors are true tumors and do not represent merely a repair reaction to inflammation.

The main factor in the clinical course of giant cell tumor requiring one to be on guard in the prognosis is rapid growth of the tumor. The typical giant cell tumor is of long duration and slow course. Rapidity of growth is a sign of aggressiveness of the tumor. Another reliable sign of aggressiveness is the destruction of a large portion of the bone shell of the tumor. The presence of the bone shell is important not because its absence is proof that the tumor has invaded the surrounding soft tissues but because destruction of the bone shell is in a moderately advanced tumor an indication of the aggressiveness of the new growth. A giant cell tumor reaching a very large size is very apt to recur after curettage since the size of the tumor excludes the possibility of a complete removal of the tumor tissue. With each recurrence the prognosis becomes less favorable. Care should be exercised in the arrival at a prognosis based upon a recurrence, because with each recurrence the growth is apt to become more anaplastic and malignant.

In relation to a prognosis the findings of a pathological examination are of outstanding significance. The giant cells of epulis type when present in excess are a true indication of the benignity of the lesion. The typical giant cell tumor where the giant cells form the bulk of the tumor is of very slow growth, not aggressive, and easily eradicated even by incomplete curettage. On the other hand with the disappearance of the giant cells and with an increase in the number of the spindle cells of the stroma the aggressiveness of the tumor increases. Viewed largely, the type of cells of the stroma is of greater importance than the giant cells. It is by the various numbers, sizes and shapes of the stroma cells that varieties of giant cell tumors are distinguished. Increase in the hyperchromatism of the stroma cell calls forth a warning as to the likelihood that a recurrence will take place after an incomplete surgical operation. A recurrence can be also expected when the stroma cells have become abundant and rounded. However, pleomorphism and cellularity in the central portion of a giant cell tumor

are not of such unfavorable significance for the prognosis as their presence in the peripheric portion of the tumor, where they notoriously mark aggressiveness. A guarded prognosis is to be given also in the case of the very vascular, so-called telangiectatic, giant cell tumor which as a rule is more aggressive and recurs more frequently than other types.